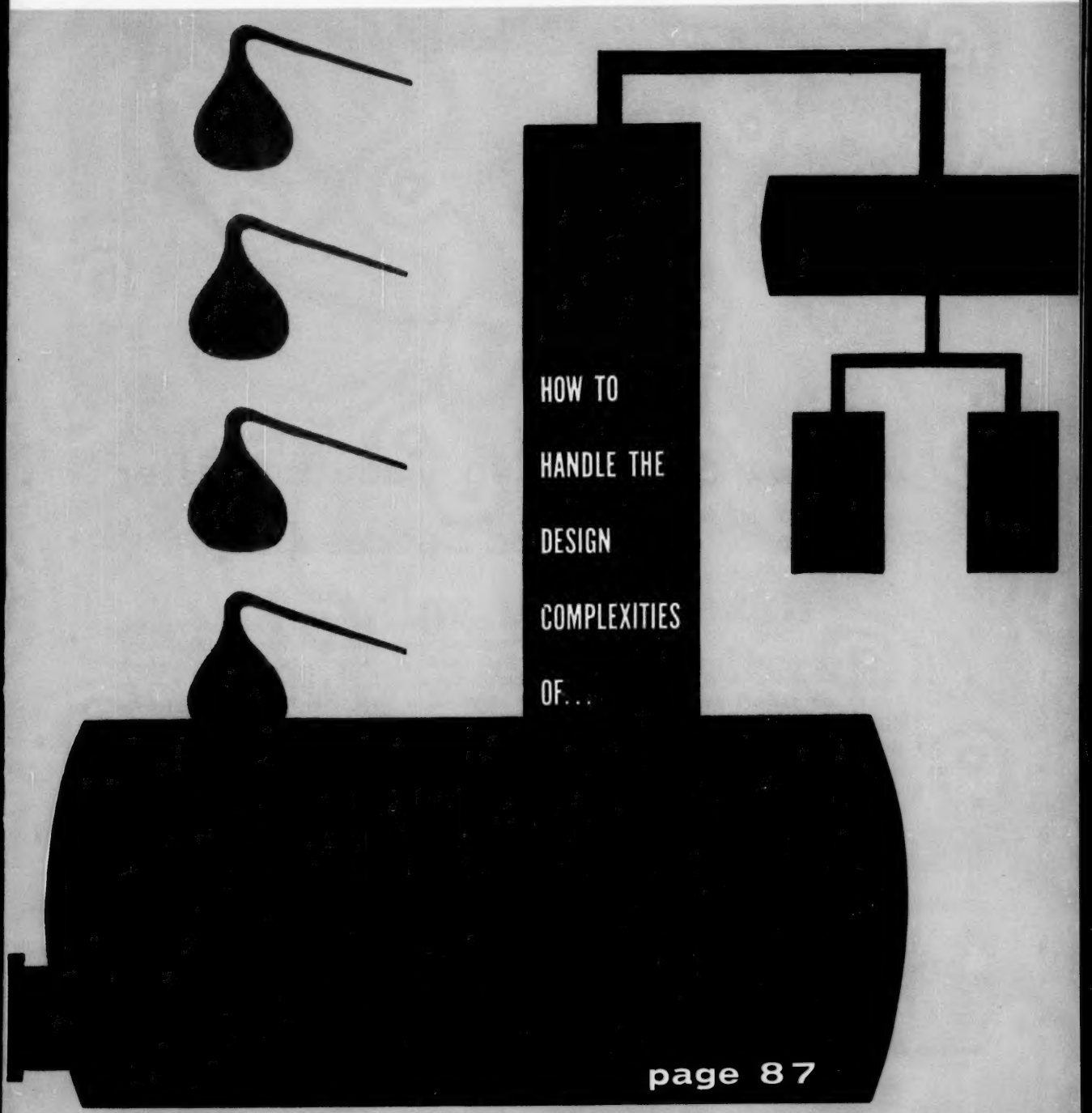
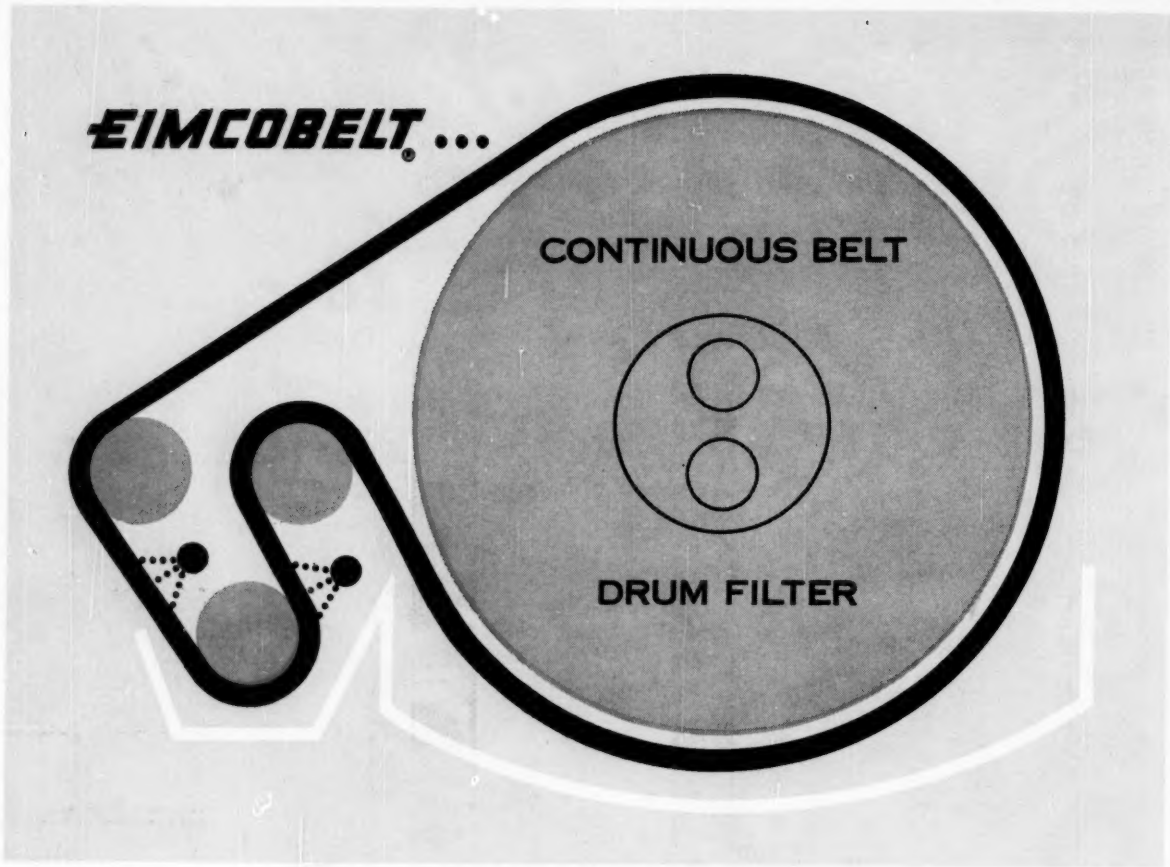
FEBRUARY 6, 1961
Published every-other-Monday
Seventy-five cents

Chemical Engineering

A McGRAW-HILL PUBLICATION



page 87



Handles Slurries No Vacuum Filter Has Ever Filtered Successfully!

. . . Continuously, and with no fall-off in filtration rate caused by progressive blinding

Because EimcoBelt filters remove the belt filter medium from the drum for cake discharge and cloth washing, continuous filtration of a wide range of difficult slurries is now possible. The filter medium is scoured clean with wash sprays, front and back, before it is returned to the drum. Blinding is eliminated. EimcoBelt filters now in operation are saving processors thousands of dollars a day filtering glutinuous slurries . . . slurries low in solids concentrations . . . slurries that have always been considered too troublesome for continuous filtration. Ask the Eimco representative in your area how EimcoBelt filters can save processing dollars in your plant. Write Eimco Filter Division for Bulletin F-2053.

"ADVANCED ENGINEERING AND QUALITY CRAFTSMANSHIP SINCE 1884"

THE EIMCO CORPORATION

EXPORT OFFICE: 51 - 52 SOUTH STREET, NEW YORK, N. Y.
BRANCHES AND DEALERS IN PRINCIPAL CITIES THROUGHOUT THE WORLD

B-683

FILTER DIVISION
634 SOUTH 4TH WEST
SALT LAKE CITY, UTAH — U.S.A.

RESEARCH AND DEVELOPMENT CENTER
301 SO. HICKS ROAD, PALATINE, ILLINOIS

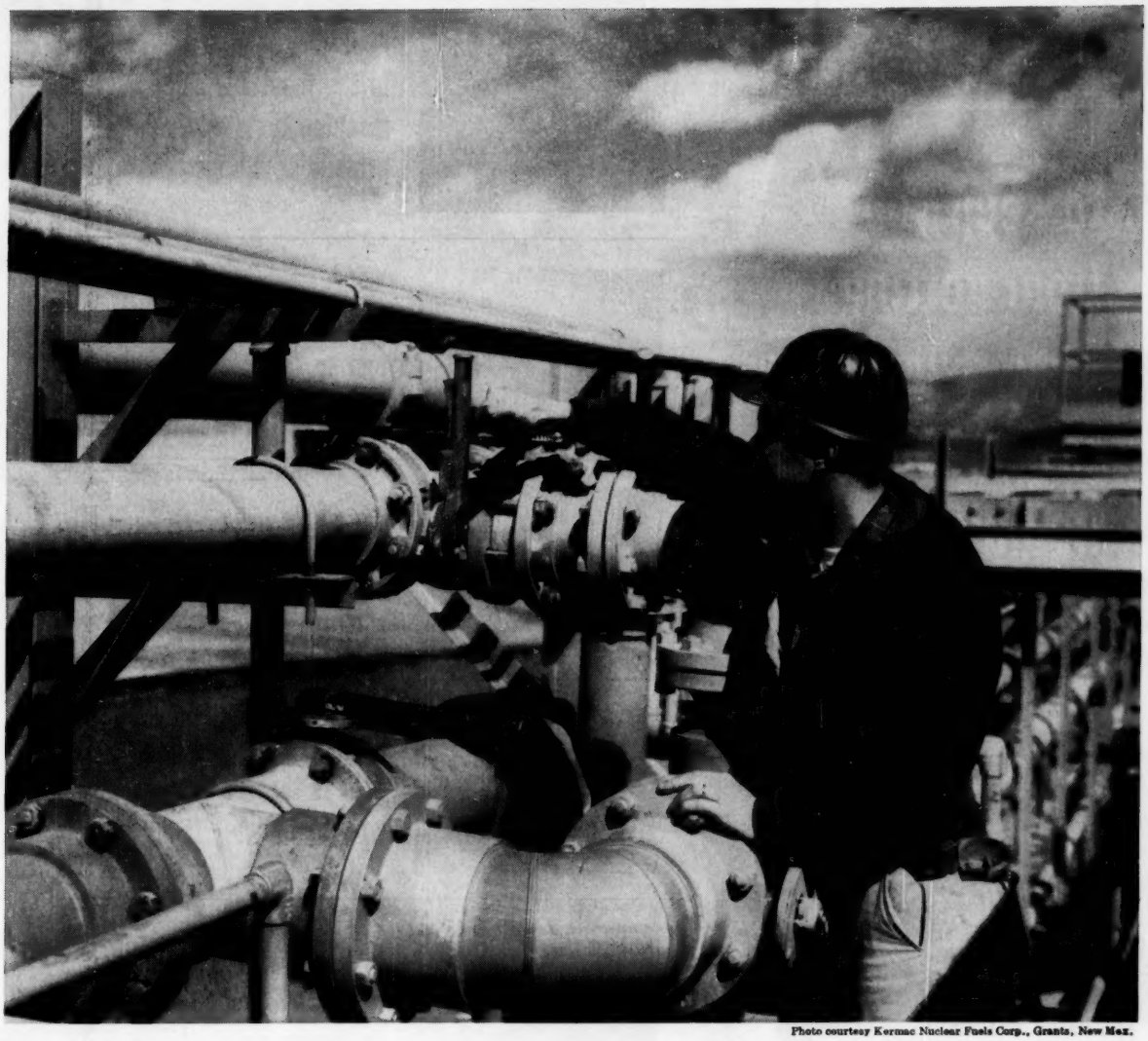


Photo courtesy Kermac Nuclear Fuels Corp., Grants, New Mex.

Imagine a pipe even strongest acids can't ruin

ENGINEERS, designing a huge uranium concentrating plant, needed pipe that could keep highly corrosive mixtures of acids and organic solutions flowing continuously—and virtually automatically — through various processing stages. Metal pipe was out of the question. Too apt to corrode.

The answer: Install pipe made of Koroseal rigid PVC by B.F.Goodrich. Koroseal pipe does not corrode, won't rust, never needs painting. It weighs only ¼ as much as steel, so it can be installed easier, faster.

Construction of the uranium plant called for nearly 4 miles of Koroseal pipe, plus hundreds of fittings and valves—the largest installation of rigid vinyl pipe in the country. After 2 years of round-the-clock service, plant engineers report, "no evidence of failure due to corrosion or abrasion".

More and more companies are finding B.F.Goodrich Koroseal PVC pipe ideal for use wherever chemical resistance, high working pressures, good impact resistance are factors. For the full story on Koroseal's many advantages, get in touch with a BFG distributor or send for a free booklet. *B. F. Goodrich Industrial Products Co., Dept. M-960, Akron 18, Ohio.*

Koroseal—T. M. Reg. U. S. Pat. Off.

Koroseal rigid PVC products by B.F.Goodrich

to keep you from getting the wrong answer to your solid-liquid separation problem

BIRD MACHINE

Invests millions of dollars.....

In the most advanced machine tools and production equipment

In comprehensive testing facilities

In research and development

In application engineering offices located in your vicinity

In world wide relationships with leading equipment designers and builders.

what's more,

BIRD

builds all types:

Bird Continuous Solid Bowl Centrifugals
Bird Continuous Screen Centrifugals
Bird-Young Drum Type Vacuum Filters
Bird-Prayon Horizontal, Pan Type Vacuum Filters
Bird Horizontal Tank, Vertical Pressure Leaf Filters
Bird Suspended Batch Centrifugals
Bird Continuous Centrifugal Classifiers

Recommendations are therefore unrestricted and unprejudiced. The machine is fitted to the job — not the job to the machine.

BIRD MACHINE COMPANY

SOUTH WALPOLE, MASSACHUSETTS

BUILDERS OF THE COMPLETE LINE OF SOLID-LIQUID SEPARATING EQUIPMENT

Operators of the Bird Research and Development Center for pilot-scale testing to determine the correct equipment for the job. Yours to use.

Application Engineering Offices:

EVANSTON, ILL. • ATLANTA, GA. • HUNTINGTON, W. VA. • LAPORTE, TEXAS • WALNUT CREEK, CALIF.

Chemical Engineering

February 6, 1961

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

PRINT ORDER FOR THIS ISSUE 52,947

WHAT'S HAPPENING

33 CHEMENTATOR *R. A. Labine*

42 INDUSTRY AND ECONOMIC NEWS *A. V. Gemmill*

42 ***CPI Twice the Size in '75***

44 ***Italian H_2CO Route Savors Success***

50 ***New Fuel Test May Cut Blending Cost***

54 ***Japanese Chemicals Boom*** *D. F. Othmer*

60 ***C P I News Briefs***

62 NEW CHEMICALS *E. Guccione*

68 NEW EQUIPMENT *F. C. Price*

68 ***New Look in Steam Generators***

70 ***Slurry Pumped, Even if It Contains Chunks***

160 ***Equipment Cost Index***

76 PROCESS FLOWSHEET *N. P. Chopey*

76 ***Winery Keeps Age-Old Process Current*** *C. R. Havighorst*

OTHER REGULAR FEATURES

142 CONVENTION CALENDAR

144 TECHNICAL BOOKSHELF

162 LETTERS: PRO & CON

165 READER SERVICE POSTCARD

167 REPRINTS NOW AVAILABLE

168 MANUFACTURERS' LITERATURE

186 CLASSIFIED ADVERTISERS

194 INDEX OF ADVERTISERS

195 ADVERTISING REPRESENTATIVES

ENGINEERING PRACTICE

87 FEATURE REPORT

87 ***Batch Distillation of Binary Mixtures Provides Versatile Process Operations*** *B. Block*

99 FEATURE ARTICLES

99 ***Estimating Air-Cooled Exchangers Made Easy*** *J. W. Murtha, Sy. H. Friedman*

101 ***Numerical Mathematics for Chemical Engineers*** *D. L. Whitley*

107 ***Computer Control*** *T. J. Williams*

112 YOU & YOUR JOB *W. C. Schall*

112 ***The Men in the Middle*** *R. R. Stokes*

FREE—For your files, an extra copy of this article. Check Reader Service Postcard, p. 166.

120 OPERATION & MAINTENANCE *P. J. Brennan*

120 ***Control Maintenance by Work Measurement*** *H. J. Chandler*

130 CORROSION FORUM *R. B. Norden*

130 ***How to Prevent Stress-Corrosion Cracking of Copper Alloys*** *D. H. Thompson*

VOLUME 68, NUMBER 3

Chemical Engineering (with Chemical & Metallurgical Engineering) is published biweekly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder.

Publication Office: 99-129 North Broadway, Albany 1, N. Y.

Executive, Editorial, Circulation and Advertising Offices, 330 West 42nd St., New York 36, N. Y. **Officers of the Publications Division:** Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. **Officers of the Corporation:** Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited from engineers and other technical men in the Chemical Process Industries. **Position, company connection, and nature of company's business, products, and approximate number of employees, must be indicated on subscription application.** Subscription rates per year for individuals in the field of the publication: U. S. and Possessions $3 (single copies 75¢). Canada $4, other Western Hemisphere $15, all others $25. The publisher, upon written request from any subscriber, agrees to refund the part of the subscription price applying to copies not yet mailed.

Second class postage paid at Albany, N. Y. Printed in U.S.A. Title registered in U.S. Patent Office.

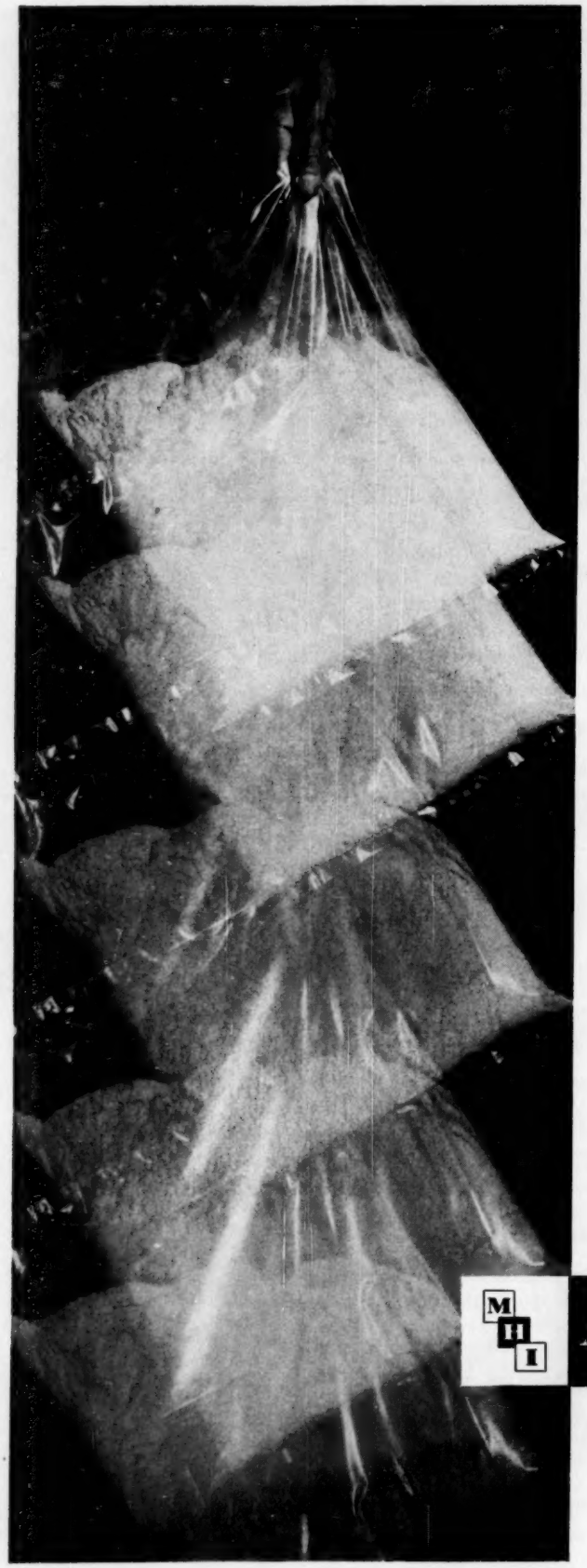
©Copyrighted 1961 by McGraw-Hill Publishing Co., Inc. All rights reserved. Member A.B.P., A.B.C.

Subscriptions: Send correspondence and change of address to Fulfillment Manager, Chemical Engineering, 330 West 42nd Street, New York 36, N. Y. Send notice promptly for change of address, giving old as well as new address. Enclose an address label from a recent issue of the magazine if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Chemical Engineering, 330 W. 42nd St., New York 36, N. Y.

Audit Bureau of Circulations

Associated Business Publications



JUST DROP IT IN! THAT'S HOW EASY IT IS TO USE MHI LITHIUM ALUMINUM HYDRIDE

Anyone can do it! All the productive reactivity of lithium aluminum hydride is safely preserved in ether soluble packaging. Filled with exact pre-determined batch amounts . . . packets are ready to be dropped directly into the reactor. Nothing could be safer, more convenient, or easier to use and store!

But this new packaging technique isn't all. Profitable applications for lithium aluminum hydride have grown, too. A recent development, for example, has shown that by combining other reagents with lithium aluminum hydride, mixed hydride systems are achieved that are exceptionally selective. In some cases reactions take an entirely new course. In others, stereospecific reduction occurs. MHI has a brochure that gives full details.

If your field of interest falls somewhere between steroid chemistry and the development of highly reactive fuels, you need the full story on lithium aluminum hydride. MHI will gladly send it to you. Experienced technical service, too, is available without obligation.

PIONEERS IN HYDRIDE CHEMISTRY

M H I

Metal Hydrides Incorporated

302 CONGRESS STREET, BEVERLY, MASS.

Calcium Hydride • Lithium Aluminum Hydride • Potassium Borohydride • Sodium Aluminum Hydride • Sodium Borohydride • Sodium Hydride Oil Dispersion • Titanium Hydride • Zirconium Hydride.

Chemical Engineering
FEBRUARY 6, 1961

PUBLISHER

J. Elton Tuohig

EDITOR-IN-CHIEF

Cecil H. Chilton

WHAT'S HAPPENING

EDITOR: Calvin S. Cronan

ASSOCIATE EDITORS: Frances Arne, A. V. Gemmill

ASSISTANT EDITORS: Nicholas P. Chopey, Eugene Guccione, Roland A. Labine, Frederick C. Price

ENGINEERING PRACTICE

EDITOR: Theodore R. Olive

ASSOCIATE EDITORS: Steven Danatos, Robert B. Norden, William C. Schall

ASSISTANT EDITORS: Peter J. Brennan, Roy V. Hughson, James R. Marshall

PRESENTATION & PRODUCTION

EDITOR: Lester B. Pope

SENIOR ART EDITOR: Frank F. Koselek, Jr.

ASSOCIATE ART EDITOR: Louis H. Dufault

ASSISTANT ART EDITOR: D. Carattas

COPY EDITOR: Henry S. Gordon

EDITORIAL ASSISTANTS: Joan Nilsen, Nancy Pepicello

REGIONAL EDITORS & BUREAUS

HOUSTON: Thomas H. Arnold, Wilma Cortines

SAN FRANCISCO: Martin D. Robbins, Terry Shaw

DOMESTIC NEWS BUREAUS: Atlanta, Chicago, Cleveland, Dallas, Detroit, Los Angeles, San Francisco, Seattle, Washington

WORLD NEWS BUREAUS: Beirut, Bonn, Caracas, London, Mexico City, Moscow, Paris, Rio de Janeiro, Tokyo. Correspondents in 170 cities in 69 countries.

CIRCULATION

MANAGER: Paul W. Erb

ADVERTISING & BUSINESS

ADVERTISING SALES MANAGER: D. B. Gridley

BUSINESS MANAGER: Anton J. Mangold

PROMOTION MANAGER: Hugh T. Sharp

MARKET RESEARCH MANAGER: Jeanette Paschall

ADVERTISING MAKEUP: Grace Barrie

highlights of this issue

BATCH DISTILLATION OF BINARY MIXTURES

In concept, batch distillation is simpler than continuous distillation. Not so with design calculation methods. Here the chemical engineer must struggle with the complexities due to varying compositions throughout the run. Drawing from his experience at Abbott Laboratories, Benjamin Block, in our Feature Report (p. 87), outlines the design procedures to follow when using constant reflux, variable reflux and intermittent total reflux.

ITALIAN FORMALDEHYDE ROUTE SAVORS SUCCESS

If repeat business is a good criterion, success has come to Montecatini's formaldehyde process. This process was first commercialized only five years ago; it is now used in four plants, with four more installations on the way. Process oxidizes methanol to formaldehyde over a metal oxide catalyst, using mineral oil as a heat-transfer medium (p. 44).

STRESS-CORROSION CRACKING OF COPPER ALLOYS

One of the fine points in selection and application of copper alloys—often overlooked by the uninitiated—is stress-corrosion cracking. David Thompson, American Brass Co. expert in this field, shows in Corrosion Forum (p. 128) just what factors cause such cracking, and also evaluates the susceptibility of various copper alloys to it.

JAPANESE CHEMICALS BOOM

Despite its lack of raw materials and low-cost energy, the Japanese chemical industry is forging ahead at a remarkable pace. What's behind this rapid growth? Brooklyn Poly's well-known Donald Othmer, recently returned from an extensive visit to Japan, analyzes the strengths and weaknesses of that nation's chemical industry, emphasizing the Japanese attitude toward research (p. 54).

The Honeywell Control Valve (foreground) regulates flow of Bunker C fuel oil burner in a chemical process drying system. In the background, a Honeywell diaphragm actuator operates a damper for control of hot air return. Nothing spectacular going on here, but the results of the entire process could well depend on these valves.

The final results—the payoff of the process—are dependent not just on how well these valves are made, not just on their capacity or sensitivity, but on *all* of these things combined . . . plus the process control knowledge that first put them to work, and the know-how that keeps them on the job.

Here, as in all Honeywell Control Valve applications, *every* aspect of valve performance has been considered in relation to the overall control system. It is this "whole picture" approach that sets Honeywell Control Valves apart, and rewards you with better processing.

Write today for your copy of our checklist, "25 Ways to Be Right" . . . in selecting control valves.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

HONEYWELL INTERNATIONAL
Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

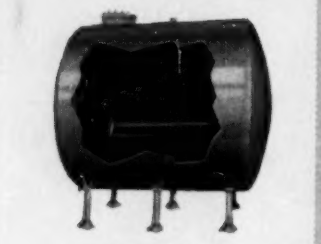
Photographed at Davison Chemical Company, a division of W. R. Grace & Company.

Honeywell

H HONEYWELL SINCE 1885 *First in Control*

No added cost to you!

"Special" 778 glass now standard



STORAGE TANKS

HEAT EXCHANGER TUBES

COLUMNS

DRYER-BLENDERS

REACTORS

on all Glascote® process equipment

When we introduced Glascote 778 glass we knew many processors would want it — but we didn't expect a **landslide!** Today so many of our customers specify this remarkably acid-resistant glass that we've made it **standard** on all Glascote reactors, columns, storage tanks, rotary dryer-blenders, pipe and fittings.

This means that, at no extra cost, you will get a unique glass lining that extends acid resistance up to 75°F higher operating temperature **with no sacrifice in its ability to resist alkali and thermal shock!**

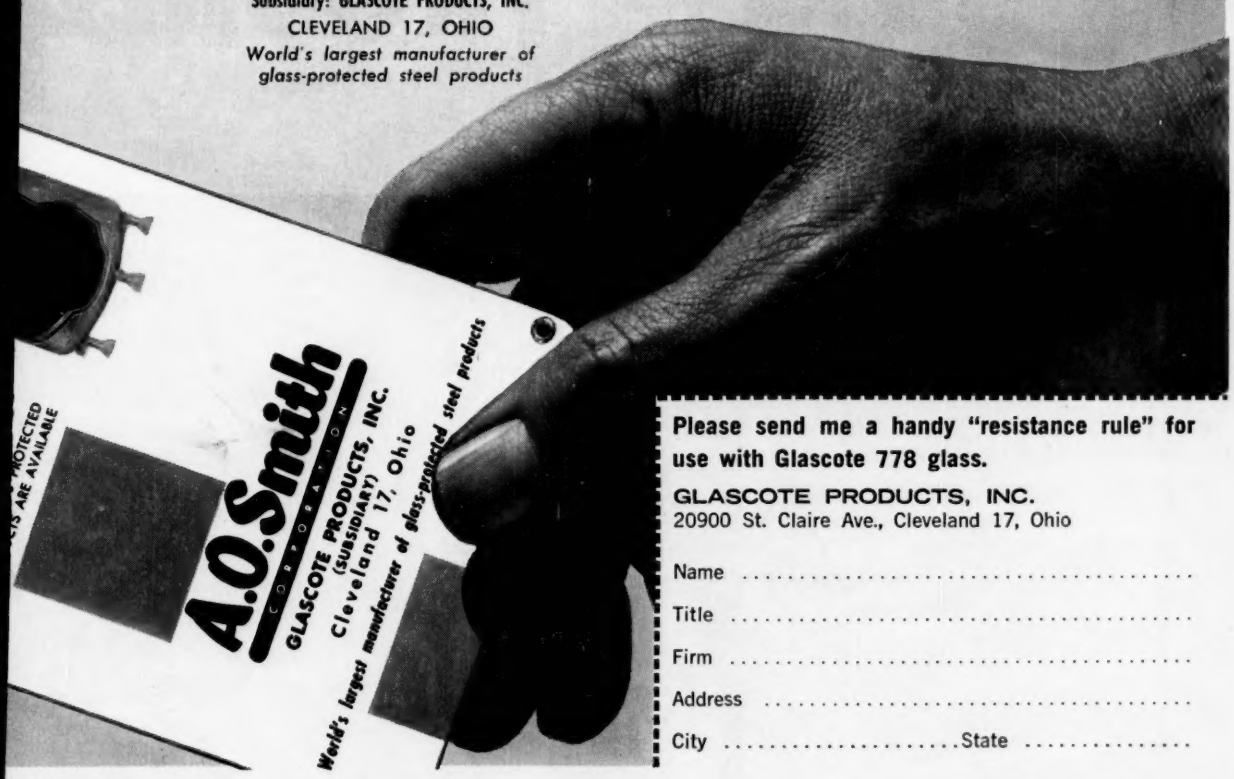
For your convenience we have prepared a "resistance rule" (pictured at left). It lists 150 hard-to-handle substances from acetaldehyde to zinc sulfate, and shows at a glance the ability of Glascote 778 to resist their corrosive attacks.

Nevertheless, despite the overwhelming popularity of 778 glass lining, you should keep in mind that this is just one of 3,000 formulations. Some may be even better for your special requirements. Ask the Glascote representative who calls on you.

Through research ... a better way

A.O.Smith
CORPORATION

Subsidiary: GLASCOTE PRODUCTS, INC.
CLEVELAND 17, OHIO
World's largest manufacturer of glass-protected steel products



Please send me a handy "resistance rule" for use with Glascote 778 glass.

GLASCOTE PRODUCTS, INC.
20900 St. Claire Ave., Cleveland 17, Ohio

Name .....
Title .....
Firm .....
Address .....
City ..... State .....

LIME

SILICATE PIGMENT

POLYVINYL CHLORIDE

SODIUM CHROMATE

SODIUM BICARBONATE

DICALCIUM PHOSPHATE

CITRIC ACID

POTASSIUM CARBONATE

BARIUM OXIDE

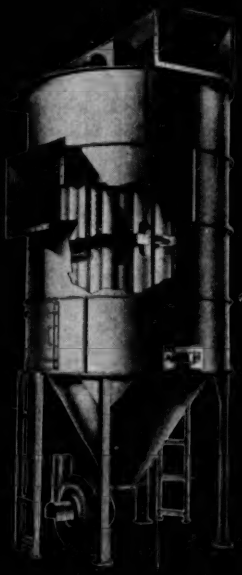
SODIUM FORMATE

BORIC POWDER

AMMONIUM NITRATE

ALUMINA HYDRATE

CARBON DUST



AMERjet—for collection of the very finest particles and particles that must be recovered dry.

CRYSTALLINE DUST

PHOSPHATE DUST

LEAD OXIDE

STARCH DUST

TITANIUM DIOXIDE

ALUMINUM OXIDE

PIGMENTS

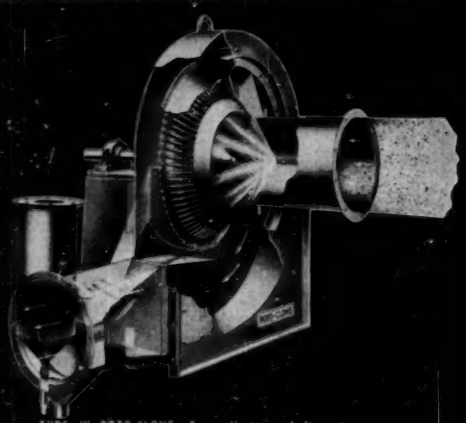
CAUSTIC VAPORS

CARBON DUST

LEAD STEARATE

CLAY

BARIUM SULFID



TYPE W ROTO-CLONE—For collection of fine dust particles in moderate concentrations.

TRIPLE TROUBLE

CUPRIC OXIDE

CALCIUM SULFATE

ALUMINA

CARBON BLACK

INSECTICIDES

AZO DYE

VOLCANIC ASH

FUNGICIDE POWDER

FERTILIZER DUST

GLYCERIN VAPOR

PLASTICS

HERMICULITE DUST

LIME

ALUMINUM POWDER

PHOSPHATES

BARIUM CARBONATE

TYPE N ROTO-CLONE—For collection of heavy dust loadings of all particle sizes.

SULPHURIC ACID MIST

ZINC STEARATE

SODIUM CITRATE

BARIUM SULFATE

ALUMINUM SILICATE

T.N.T.

SODIUM SILICATE

AMMONIUM SULFATE

METALLIC OXIDES

BAUXITE

PIGMENTS

PHENOLIC RESINS

FOR DUST!

THESE AAF UNITS DO MANY JOBS FOR CHEMICAL PROCESSORS

The materials at left are but a smattering of the hundreds being efficiently and economically collected for the chemical industry by AAF's AMERjet and wet-collecting ROTO-CLONES.

All three units offer these four basic design features: (1) small space requirements, (2) maintained performance over a wide range of operating conditions, (3) constant exhaust volume, and (4) high collection efficiency.

For more complete information on any or all of these units, call your local AAF representative or write direct for Type W Bulletin 272B; Type N Bulletin 277; AMERjet Bulletin 279. Address Mr. Robert Moore, American Air Filter Company, Inc., 326 Central Ave., Louisville, Kentucky.

AAF American Air Filter

BETTER AIR IS OUR BUSINESS

ALGO*

FOR THE BENDIX G-15 COMPUTER

Speeds and Simplifies Problem Solving

ALGO extends the problem-solving horizon of every engineer, focusing the speed and precision of the Bendix G-15 computer on any algebraically stated problem. ● A true mathematical equation solver, ALGO permits any engineer or scientist to program the computer in universal mathematical language. No previous knowledge of computers or programming is needed. Input/output, computation and data handling are all automatically controlled by the G-15 computer. ● Compare the number of steps in the ALGO program illustrated below with the number required to solve the same problem on a slide rule, desk calculator or any other computing system. You will see the time and cost-saving significance of this new Bendix G-15 automatic programming aid. ● Specifically designed to take advantage of the computing power and flexibility of the proven G-15, ALGO is the newest addition to an extensive library of Bendix automatic programming systems. See how the low-cost Bendix G-15 and ALGO combine to broaden application boundaries. Learn how this powerful team can save you valuable time . . . and greatly simplify problem solving.

* AN ALGEBRAIC COMPILER BASED ON INTERNATIONAL ALGOL.

PROBLEM: $$I = \frac{E}{\sqrt{R^2 + (6.2832\,FL - 1/6.2832\,FC)^2}}$$

(For values of R, F & L as specified. For values of E ranging from 100 to 300 in increments of 50. For values of C ranging from .00002 to .000021 in increments of .0000001)

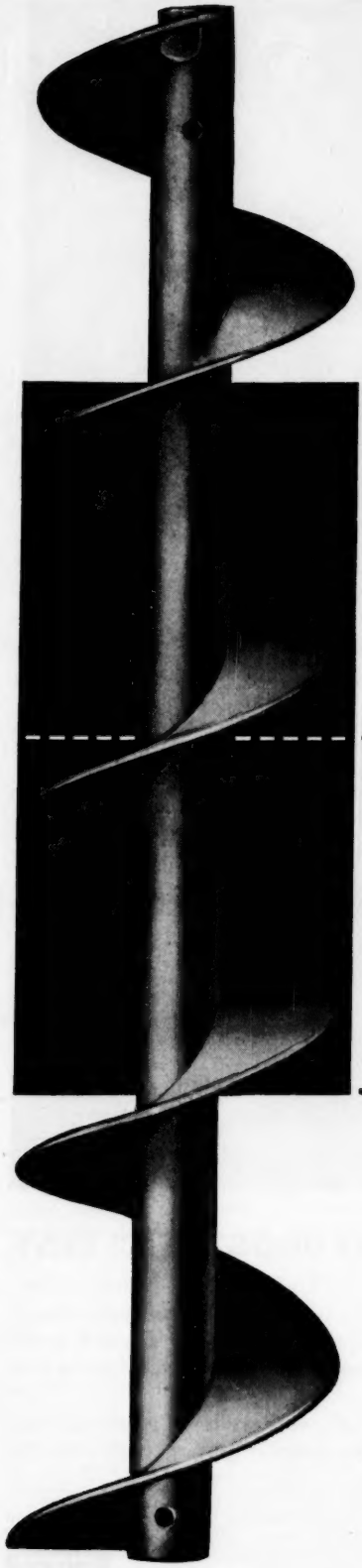
COMPLETE ALGO PROGRAM:

```
BEGIN ⑤
R = 10 ⑤
F = 60 ⑤
L = ₀2 ⑤
FOR E = 100(50)300 BEGIN ⑤
FOR C = ₀00002(₀0000001)₀000021 BEGIN ⑤
I = E/SQRT(R ↑ 2 + (6₀2832 * F * L — (1/(6₀2832 * F * C))) ↑ 2) ⑤
PRINT (FL) = E ⑤
PRINT (FL) = C ⑤
PRINT (FL) = I ⑤
```

Write on your letterhead for the self-teaching ALGO manual.

Bendix Computer Division
DEPT. O-23 LOS ANGELES 45, CALIF.

THE Bendix CORPORATION



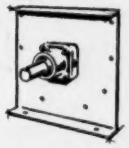
LINK-BELT is

YOUR ONE SOURCE FOR ALL SCREW CONVEYOR NEEDS

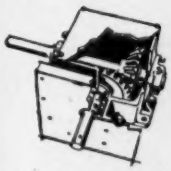
your only source for many

QUIK-LINK CONVEYOR SCREW. For ease in removal of conveyor section without disturbing other components. Can be furnished on Helicoid and Sectional flight conveyors.

HANGERS have wide top bar with slotted bolt holes for easy assembly and alignment. Available with self-aligning ball bearing or with sleeve bearing in babbitt, hard iron, bronze or oil impregnated wood.



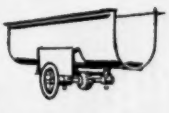
TROUGH ENDS of heavy steel plate are flanged at top and bottom. Furnished with babbitted, bronze or single or double ball bearing flange block, with or without trough end seal. Blocks are interchangeable.



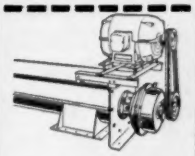
COUNTERSHAFT ENDS with ball and roller bearings or babbitted bearings, for right angle drive applications— common drive for two conveyors at right angles.

TROUGHS are accurately formed and jig-assembled. Steel angles securely welded to trough plate form top flanges. Can be made of stainless steel or other special metals to suit specific requirements.

SEMI - FLANGED, SPRING CLAMP COVERS are more rigid, easier to handle and form a tighter seal than plain type cover. Spring clamps are attached to cover—simplifies installation.



DISCHARGE SPOUTS AND GATES can be located anywhere along length of conveyor trough. Gates can be flat or curved —hand or rack-and-pinion operated.



DRIVES. Link-Belt shaft-mounted speed reducers are simple, compact — can be mounted directly on trough end plate. Motogears and Gearmotors with roller chain drives can also be furnished.

With seventeen basic screw designs, and a full line of components, Link-Belt can furnish anything you need from a single component to a complete line of screw conveyor.

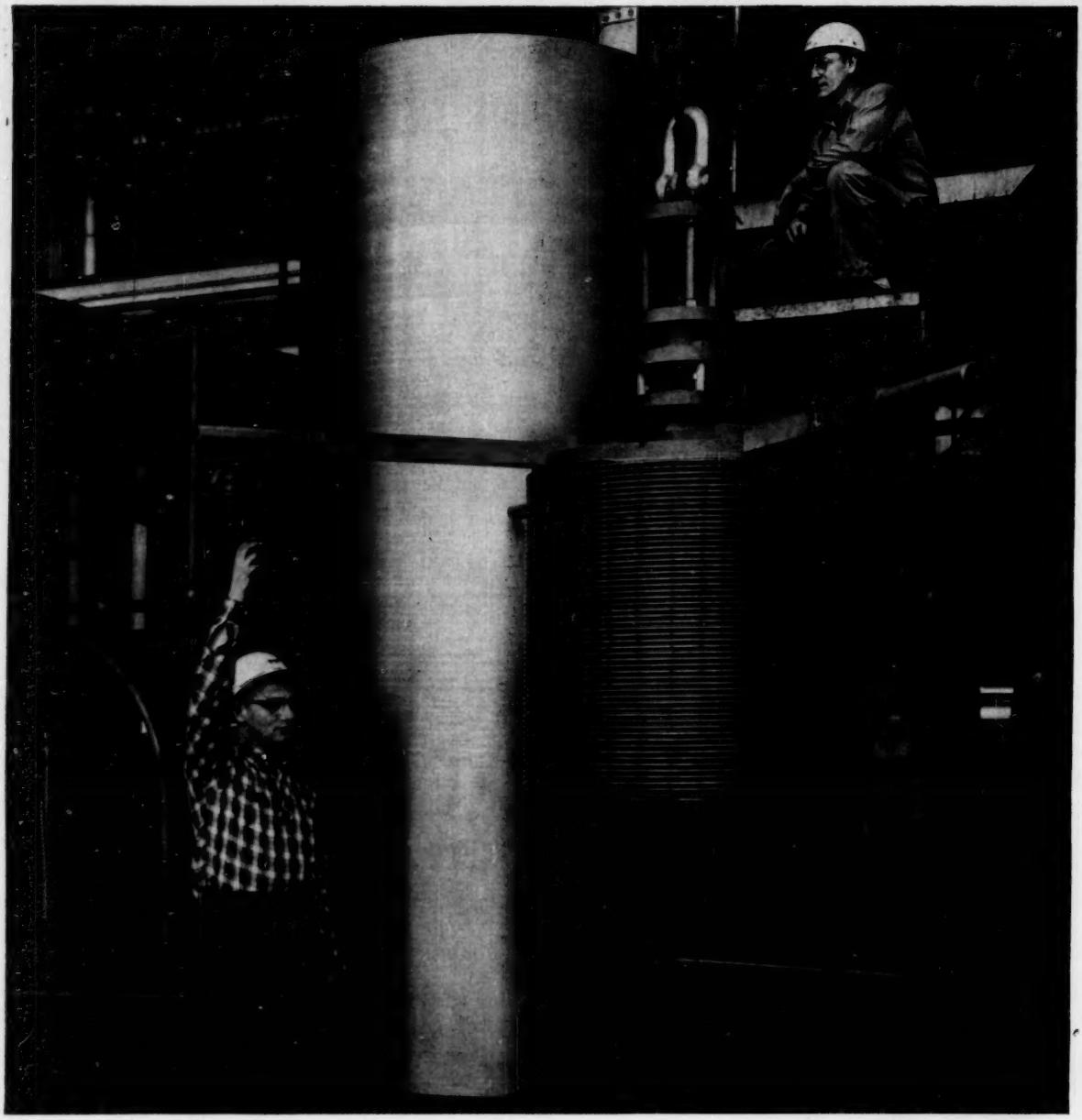
As the foremost producer in this field, Link-Belt offers a range of new product improvements for profitable operation. Quik-Link conveyor screws, hangers, trough ends with ball or sleeve bearings, jig-welded troughs with new semi-flanged spring clamp covers—these and many more are cutting power demands and maintenance costs.

If you have bulk materials to be handled, it will pay you to look into the Link-Belt screw conveyor line. All components are available from stock. Call or write your nearest Link-Belt office or authorized stock-carrying distributor for Book 2989.

LINK-BELT

SCREW CONVEYOR

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.



THIS FORGED PRESSURE VESSEL GOT A HYDROSTATIC TEST IN EXCESS OF 70,000 PSI Designed by Harwood Engineering Company, Inc., Walpole, Mass., for Fansteel Metallurgical Corporation, North Chicago, Illinois, this pressure vessel is of two-layer, shrink-fit construction.

The two shells and all the head closure parts were forged by Bethlehem from alloy steel, then heat-treated, finish-machined, and assembled in Bethlehem shops. The vessel measures 122 inches in length and weighs a bit over 30 tons. Diameter inside is 18 inches; outside it's 49½ inches.

Like all Bethlehem forged vessels—whether they tip the scale at 150 tons or 900 pounds—this one is built for long, heavy-duty service. Our technical men will be glad to work closely with you. Once the design is approved, you can count on our shops to follow-through with a first-rate production job.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa. *Export Sales:* Bethlehem Steel Export Corporation

Steel *for Strength ... Economy ... Versatility*

BETHLEHEM STEEL

BETHLEHEM STEEL

SILICONE NEWS from Dow Corning

Foam . . . Pfft!

Eliminate Costly Boil-overs With Dow Corning Silicones

When foam takes over — as it did at the processing plant shown above — you've got real trouble! Production goes down, maintenance costs soar, and customers go to the second source. Then, to top it all off, your operations report shows "red".

How do you stop foam and make your problems go pfft? Easy—use fast-acting Dow Corning Silicones. Antifoamer or defoamer, these job-proved process aids give you complete, low-cost control over foam . . . enable you to operate at maximum capacity without costly shut-downs.

"Mighty Mite." The powerful defoaming action of Dow Corning Silicones means that as little as a teaspoonful can control foam in several hundred gallons of foamer. Effective concentration in most industrial uses is in the range of 0.0001 to 0.02 percent. In some instances, this means a cost so slight that it's hard to find on an operations cost sheet.

Work, work, work. Dow Corning defoamers and antifoamers work fast with a wide variety of products: chemicals, petroleum, asphalt, textiles, paper, paints, adhesives. There are even special food grade silicone defoamers sanctioned by FDA.

Also important: By using Dow Corning Silicones to prevent boil-overs, you reduce fire hazards.

Free Sample. Here's your chance to make foam go pfft without spending a penny. Tell us your foam problem and type of system — oil, aqueous, nonaqueous, food product, or other. Your trial sample will be sent by return mail. Write Dept. 1814.

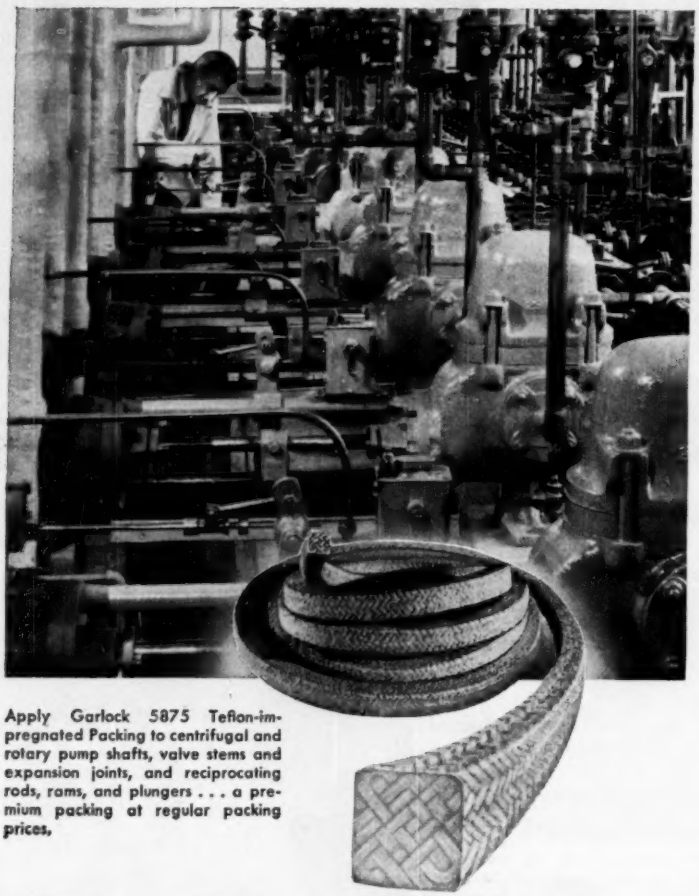
FREE, new brochure, "How Silicones Work for the CPI"

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

ENGINEERED TEFLON PRODUCTS
for Chemical Processing



Apply Garlock 5875 Teflon-impregnated Packing to centrifugal and rotary pump shafts, valve stems and expansion joints, and reciprocating rods, rams, and plungers . . . a premium packing at regular packing prices.

NOW—YOU CAN BUY GARLOCK TEFLON* PUMP PACKING AT REGULAR PACKING PRICES!

Through an improved manufacturing technique, Garlock offers a Teflon-impregnated LATTICE BRAID† Packing at a reduction of approximately 40% over the price of similar competitive packing. Designated Garlock 5875, this packing can be purchased at prices comparable to regular packing.

Enjoy premium benefits without a premium price. Garlock 5875 offers a high Teflon content—more than 30% by actual weight—for greater protection, reduced wear. In temperatures from −90° F to +500° F, Teflon-impregnated LATTICE BRAID Packing is recommended for use against moderately destructive and corrosive mineral acids and caustics. For more destructive and corrosive applications, Garlock 5888 Teflon-treated fiber packing is recommended. Teflon, too, is as "frictionless" a material as you will find; this greatly reduces wear to the packing itself, and to any moving parts that it contacts during normal operation.

Specialized construction provides longer life, less maintenance. Garlock 5875 Packing is made from Teflon-impregnated white asbestos yarn, woven in the superior LATTICE BRAID construction. Here, each strand of treated yarn is intertwined at a 45° angle through the packing body. This completely integrates the structure for greater strength and, unlike ordinary square or round braid, eliminates individual *layers* of yarn—layers that, once worn through, destroy the usefulness of the packing. Without a layer or single outer braid to wear through, LATTICE BRAID remains unified without disintegrating far beyond the limits of other packings.

Enjoy fast delivery from warehouse stock. Garlock 5875 Packing is immediately available in sizes from ¼″ through ⅝″ in either spool or reel form to meet your specific needs; also available on order in ring form in these sizes. Specify now from your local Garlock representative at the nearest of the 26

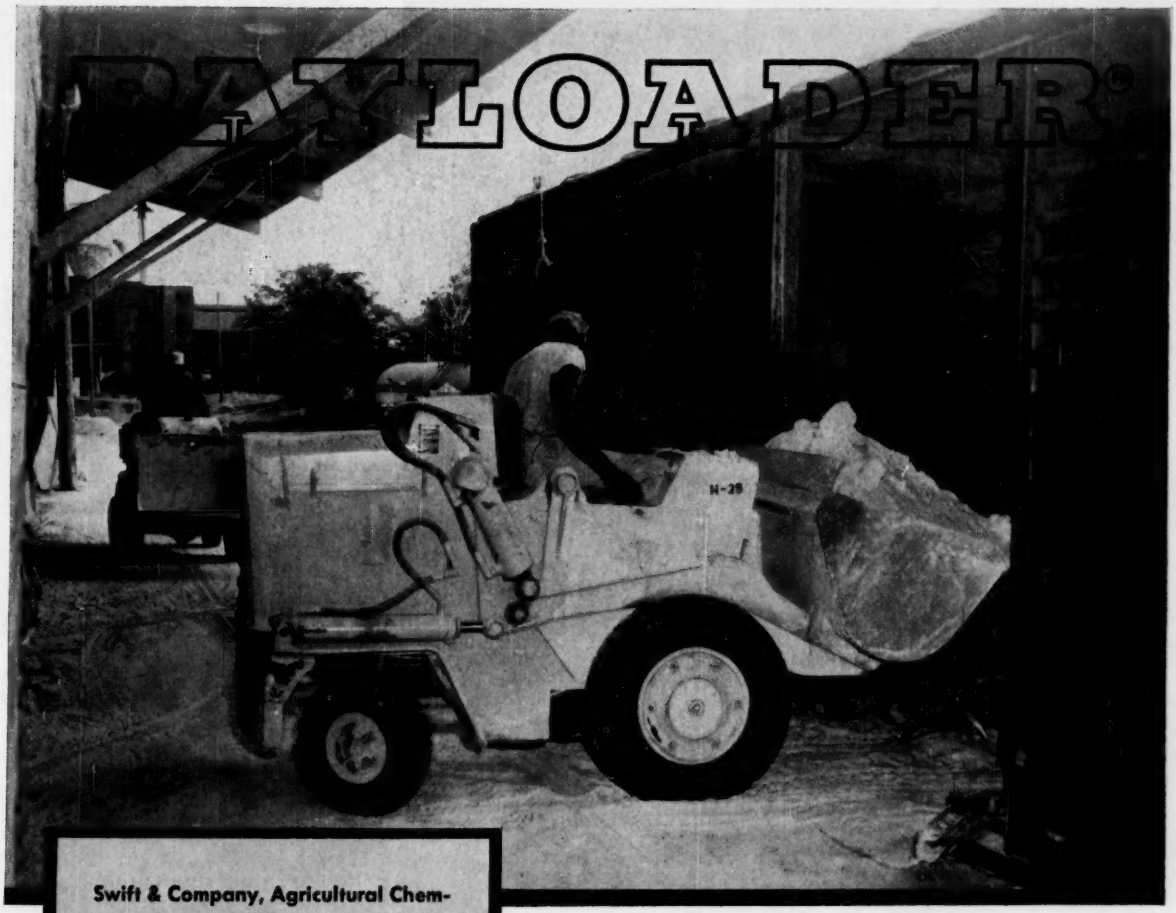
GARLOCK

Garlock sales offices and warehouses throughout the U.S. and Canada. Or, for more information, write for Catalog AD-185, Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*DuPont Trademark for TFE Fluorocarbon Resin
†Registered Trademark



Swift & Company, Agricultural Chemical Division, is one of the oldest and largest of fertilizer manufacturers. It was one of the first chemical companies to use integral-design tractor-shovels as pioneered by The Frank G. Hough Co. some 20 years ago, and has purchased several hundred of these PAYLOADER units. Moreover, the advice, counsel and criticism from Swift personnel have contributed much to the continual improvement of PAYLOADER designs through the years — a fact that the Hough organization appreciates and is glad to acknowledge.

HOUGH®

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY – INTERNATIONAL HARVESTER COMPANY

HOUGH, PAYLOADER, PAYMOVER, PAYLOGGER and PAY are registered trademark names of The Frank G. Hough Co., Libertyville, Illinois

Production Protection

Superintendents of fertilizer plants will agree that "dependability" is an important, if not the chief, consideration when they buy mechanical equipment. A mechanical failure anywhere along the line, especially during night-and-day peak-season operations, can be a serious and costly interruption.

Hough engineers know this too, and have designed more production-protection into the Model H-25 PAYLOADER than has ever before been provided in a tractor-shovel. As one plant superintendent testifies, "The maintenance on our two H-25's has been lower than on any loader previously used."

Extraordinary Protection includes two-stage dry-type air cleaner system; cartridge-type oil filters on all three oil systems; sealed, self-adjusting hydraulic service brakes; parking brake enclosed in transmission; special grease and oil seals on all vital points.

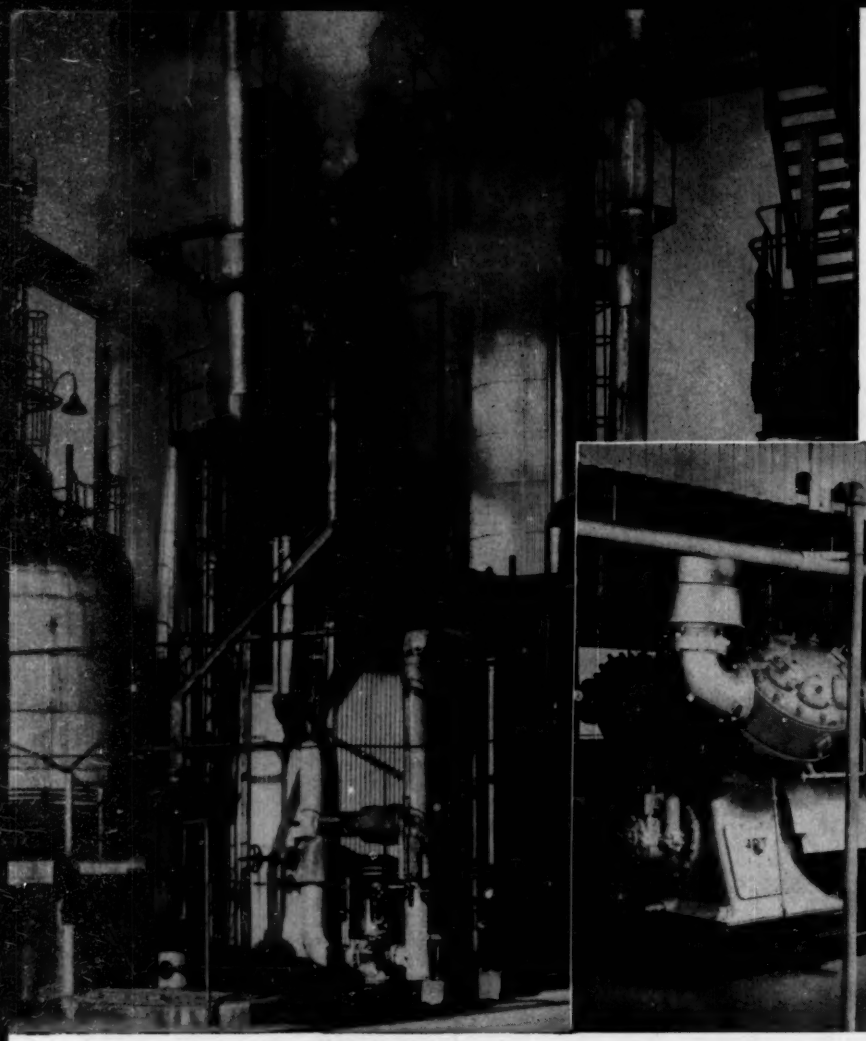
Your Hough Distributor will be glad to show you how the H-25's greater-production and lower-maintenance can help "ease the profit squeeze" of your bulk handling.

THE FRANK G. HOUGH CO., 754 Sunnyside Ave., Libertyville, Ill.

Send "Industrial Materials Handling from A to Z"

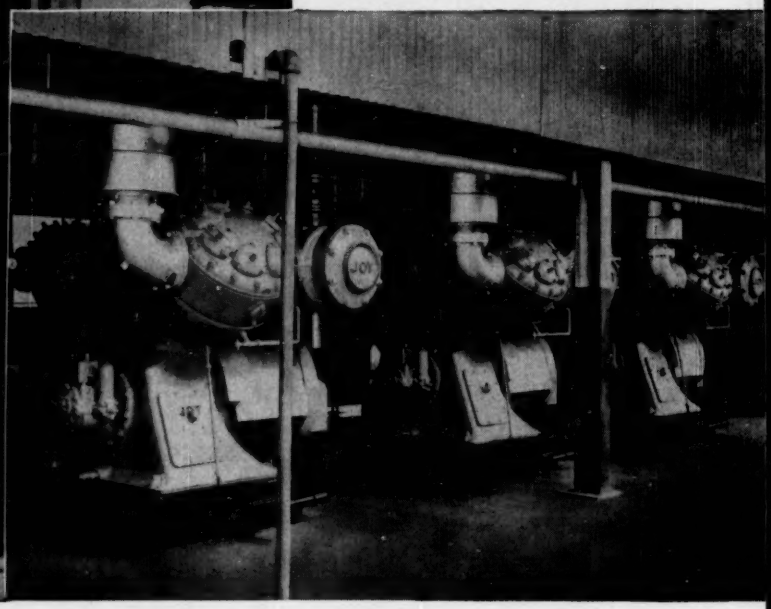
Name
Title
Company
Street
City State

2-A-1



150 pound air from Joy compressors enters process stream as it leaves the primary reformer at Southern Nitrogen's ammonia plant in Savannah, Ga.

Three Joy WN-112's have provided trouble-free service since the plant was built.



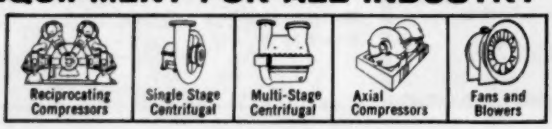
JOY WN-112 COMPRESSORS SUPPLY HIGH PRESSURE PROCESS AIR AT SOUTHERN NITROGEN COMPANY'S AMMONIA PLANT

Three Joy WN-112 Compressors supply 150 pound air for the methane reforming process at Southern Nitrogen Company's ammonia plant in Savannah, Ga. Feeding air directly into the stream coming off the primary reformer, the compressors run continuously for several months at a stretch.

Like all Joy compressors, Joy WN-112's are built for the rugged duty requirements of continuous processes with a minimum of maintenance and downtime. Cylinder liners and cross-head guides are replaceable—an exclusive Joy feature which cuts downtime to a fraction in the event that a cylinder wall is accidentally scored.

WN-112's are only one of the many types and sizes of Joy compressors available for process applications involving the compression of air or gases. Reciprocating compressors are available in standard or oil-free construction in sizes from 15 to 1250 hp.; single and multi-stage centrifugals and axial flow compressors from 15 to 15,000 hp. For complete information on Joy compressors for the process industry, write for Bulletin 2562-11.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

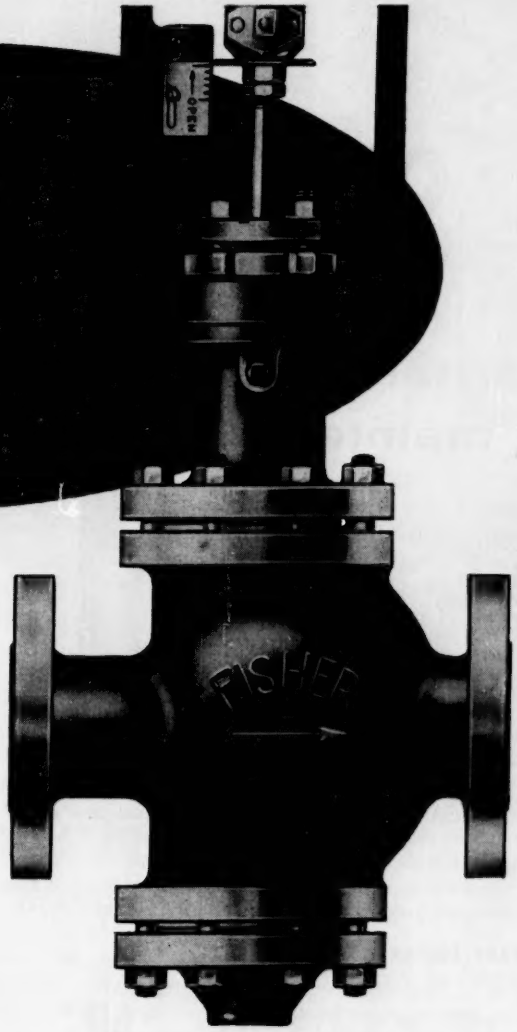


JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

Saves up to 23% over cost of steel valves!



Fisher nodular iron control valves

●Nodular Cast (ductile) Iron valve bodies have higher yield strength than steel ● Ability to resist mechanical shock compares favorably to steel ● NCI valves have been tested at three times their rated pressure ● Corrosion resistance is as good, and generally better, than cast iron or carbon steel ● Effective in temperature ranges of −20°F. to +650°F. and pressures up to 1,000 psi. ● Shock or impact characteristics are comparable to steel ●

For more information, send for Technical Paper TM-5. Fisher Governor Company, Marshalltown, Iowa. Plants in Woodstock, Ont., Rochester, England. Butterfly Valve Division: Continental Equipment Co., Coraopolis, Pa.

NCI VALVE BODY SPECIFICATIONS

Body Styles—Double or single port globe bodies • **Body Sizes**—½ through 12" • **End Connections**—Screwed, ASA raised face or RTJ 150 to 600 psi flanges • **Plug Style**—Top and Bottom guided, V-Pup or Throttle Plug • **Pressure**—Temperature Ratings—Pressure 80% of corresponding steel flanges at a given temperature with maximum pressure up to 1,000 psi and maximum temperature 650°F. **Minimum Temperature**—Minus 20°F.

COMPARISON OF MECHANICAL PROPERTIES

	Cast Iron ASTM A126-B	Nodular Iron ASTM A395	Cast Steel ASTM A216-WCB
Tensile Strength, PSI	31,000 Min.	60,000 Min.	70,000 Min.
Yield Strength, PSI	———	45,000* Min.	36,000 Min.
Elongation, % in 2" Gage Length	NIL	15	22
Modulus of Elasticity, PSI	12—20x10⁶	24x10⁶	30x10⁶

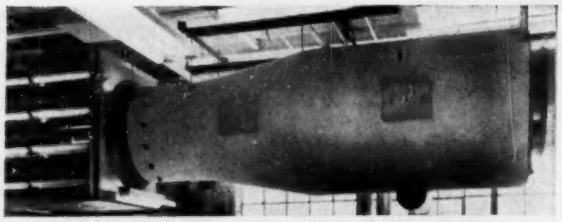
*0.2% Offset

If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER®
SINCE 1880

SELF CLEANING?
SELF CLEANING!

Carrier Rotaspray Air Conditioner reduces maintenance costs as much as 80%!



Carrier Rotaspray Weathermaker units may be installed rooftop mounted, ceiling suspended or outside wall mounted.

Its revolutionary self-cleaning action is just one of 17 reasons why the Carrier Rotaspray Weathermaker* System has proved itself far superior to conventional close-control air conditioning systems. In the majority of applications no filters are needed. Among the other reasons:

UNITARY DESIGN

Instead of one large conventional central station system serving several departments, each department has its own Rotaspray unit and can change its temperature and humidity to meet its individual needs.

SMALLER SIZE

A Rotaspray unit requires less than one-third the space of a conventional system of equal capacity.

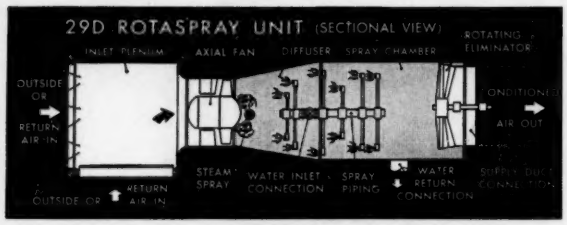
ELIMINATES MANY COMPONENTS

Units require no water strainer, water pump, water tanks, city water or drain piping. No apparatus room and no floor drains needed.

BETTER TEMPERATURE AND HUMIDITY CONTROL

Eliminates dew point control and its problems. Within Rotaspray System capacity, departments simply "dial" the temperature and humidity required.

The Carrier Rotaspray System also offers lower installation costs, superior efficiency and substantial savings in operation and maintenance. For information, write Carrier Air Conditioning Company, Syracuse 1, New York. In Canada: Carrier Air Conditioning Ltd., Toronto 14.



HOW CARRIER ROTASPRAY WEATHERMAKERS WORK

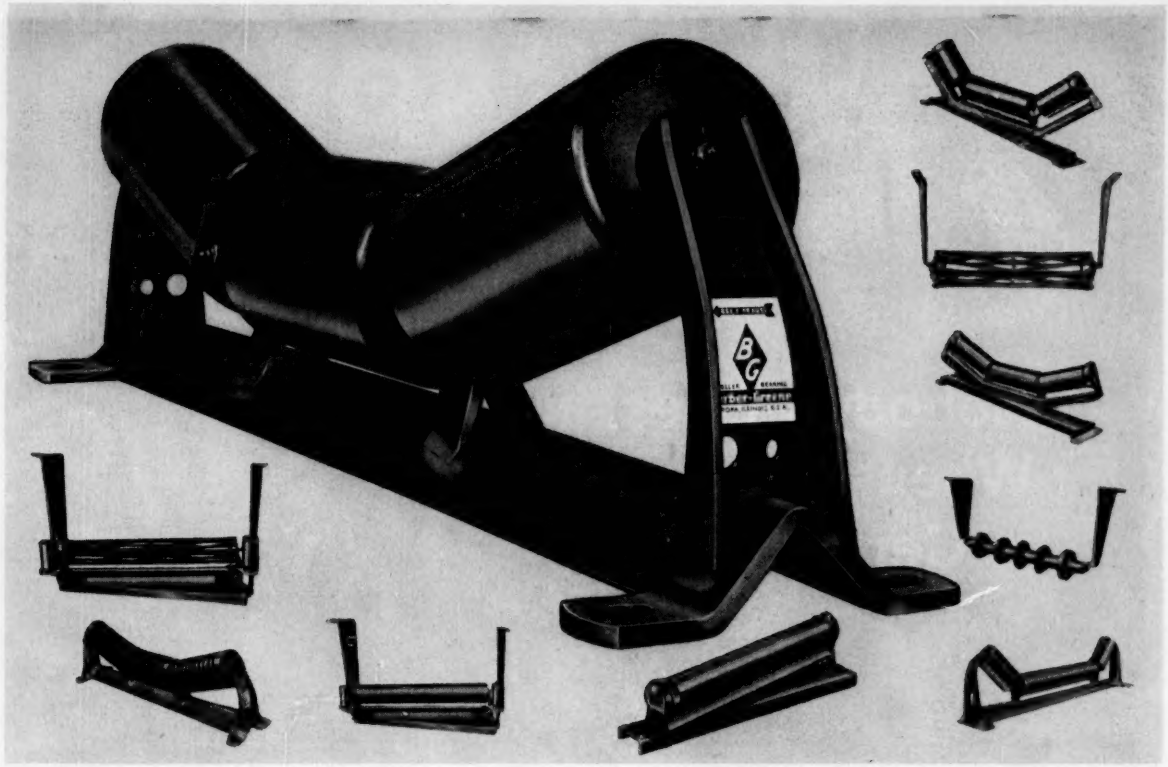
Instead of trying to keep lint and coarse airborne particles out as conventional central station systems do, the Carrier Rotaspray Weathermaker System lets them enter, separates them from the air, and returns the debris to a central point for automatic collection and disposal.

The sectional diagram of a Rotaspray unit above shows how:

- A specially designed high-velocity vane axial fan draws a controlled mixture of outside and return air into the cylindrical stainless steel spray chamber.
- Here, a finely divided water spray treats the air mixture and cleans it of dirt and airborne particles, where they drain out in the water return connection for central collection and disposal.
- As the conditioned air leaves the Rotaspray unit, it passes through an exclusive rotating eliminator that removes the entrained water particles from the air before it passes through a reheater, ductwork and outlets into the conditioned space.
- Lint and debris accumulated on fan blades and the rotating eliminators are thrown off by centrifugal force, and flushed by spray water into the spray section for immediate drain disposal. There's no "tank of water" to collect lint.
- The Rotaspray Weathermaker System offers all the advantages of unitary design with central station performance. A single refrigeration machine with chilled water storage tank and automatic strainer will handle a multiple unit system, with Rotaspray units at many remote points.

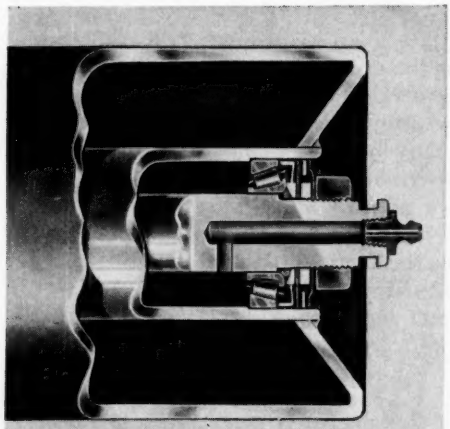
*Reg. U. S. Pat. Off.

Carrier Air Conditioning Company
A DIVISION OF CARRIER CORPORATION



Today's best buy in Idlers...

broadest line of quality idlers at lowest price



HEAVY-DUTY IDLER FEATURES: exclusive combination nylon-and-metal face and labyrinth seal; tapered roller bearings; exclusive neoprene rubber "O" ring; material-shedding recessed roll ends; large capacity grease reservoir; and fittings that provide direct lubrication of each roll.

These are just a few of the Barber-Greene features that assure you of the most idler for your money:

- Broadest line—more than 800 different types and styles in four complete series, offering an idler exactly right for your conveyors.
- Larger bearings give longer service under most adverse conditions.
- Larger diameter, solid through-shafts of special high-alloy steel maintain roll alignment.
- Most advanced grease seals on the market assure maximum bearing life.
- Die-formed steel end and center brackets withstand far more punishment than malleable iron.
- Heavy self-shedding base angle ensures alignment, prevents material build-up under rolls.
- Rolls shells fabricated from heavy steel tubing of uniform wall thickness for even wear and balance.
- End cups 100% welded to roll shell forming sealed, rugged, extra-duty roll.
- Positive lubrication of each bearing prolongs bearing life.
- Rolls are interchangeable and readily replaced in stands.

See your Barber-Greene Distributor for today's best buy in idlers . . . or the most imaginative and economical design for your conveyor system.

Your belt conveyor equipment headquarters

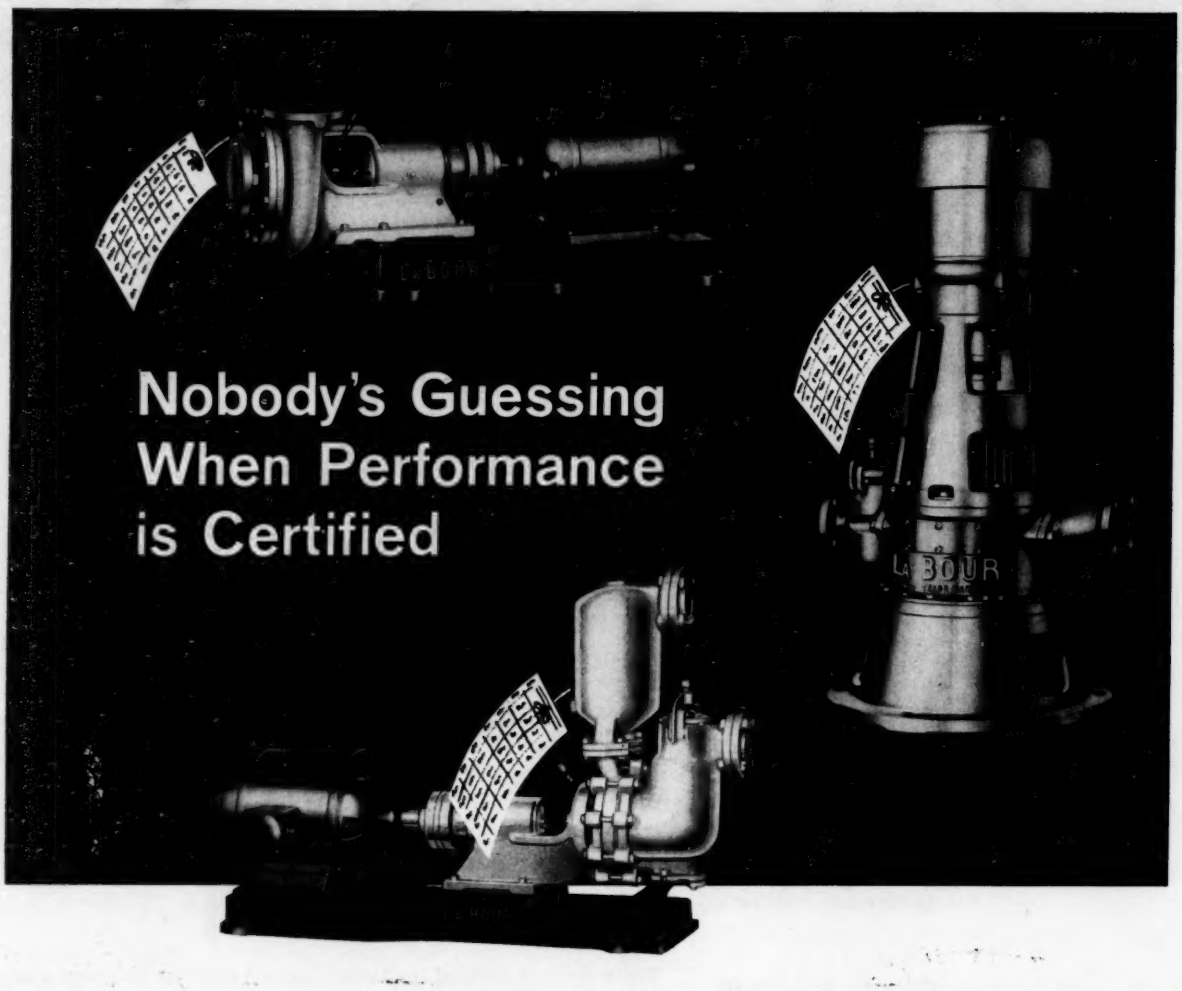
Representatives in Principal Cities of the World

Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.

Other Plants: DeKalb, Milwaukee, Detroit, Canada, England, Brazil, Australia

CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT



Performance of a centrifugal pump, particularly of a self-priming type, can be greatly affected by small variations at critical internal points. The simplest as well as the most reliable check of such a pump is actual work.

That's why standard procedure at LaBour is an operating test of every pump before shipment, with a permanent record of performance as regards capacity, head, speed of prime, wet and dry vacuum, or other pertinent data depending on the order. Of course, no LaBour pump can leave the factory unless it meets the customer's performance specifications, whatever they may be. The buyer of a LaBour pump may receive a certified transcript of its performance record.

Nobody ever guesses what a LaBour pump will do. All the facts are known before it is installed. If you want real assurance of pump adequacy and dependability, specify LaBour.

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

THE LaBOUR COMPANY, INC. • ELKHART, INDIANA
WHITE PIGEON, MICH. • LONDON, ENGLAND

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

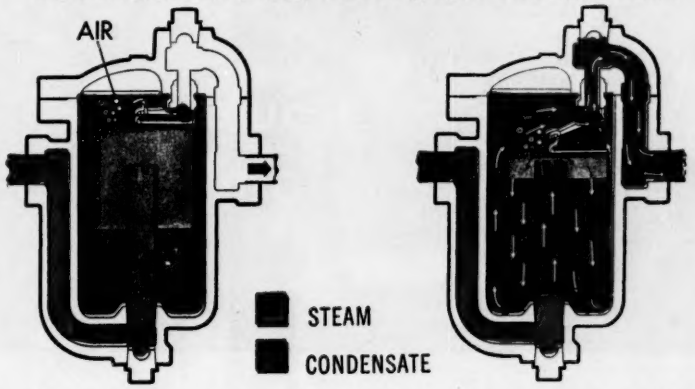
You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

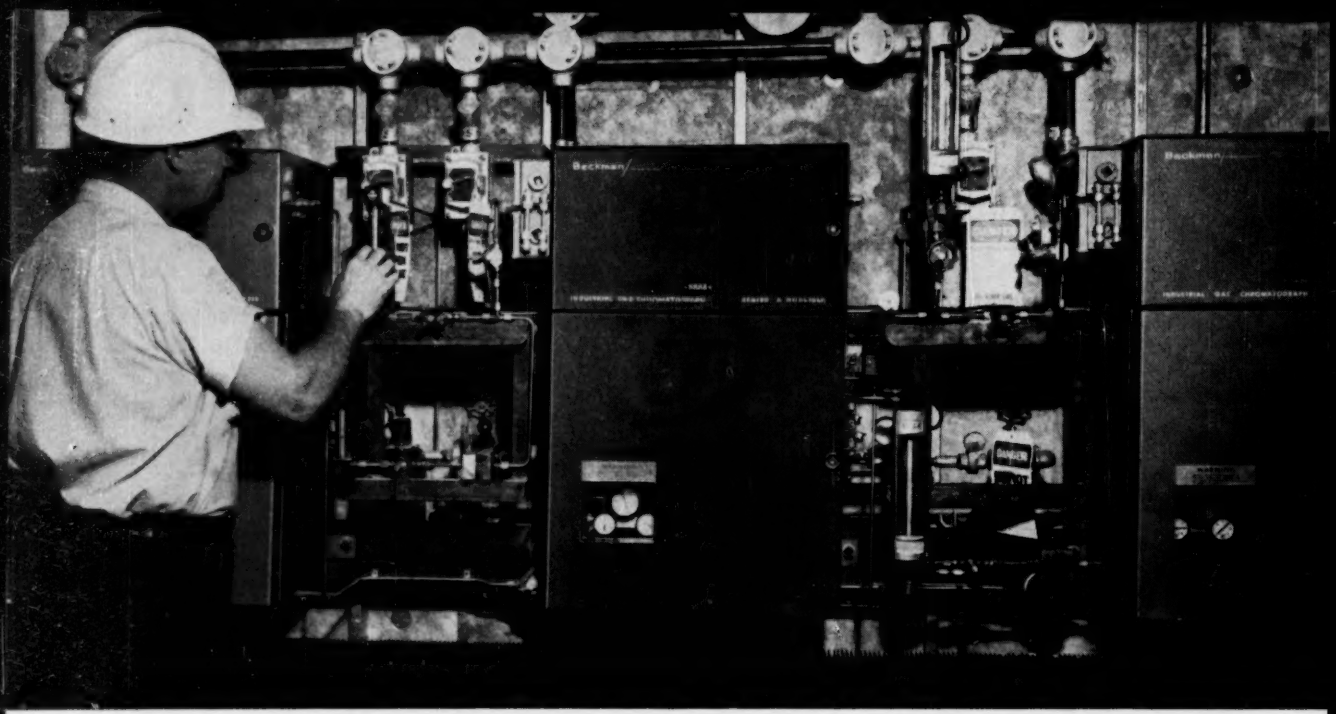
* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8581 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS
813-ST

See our catalog in Sweet's Plant Engineering File



Know-how by Dow... chromatography by Beckman. Beckman gas chromatography analyzers have been making intermediate and end-product analyses of the ethylene process at the Dow Chemical plant, Bay City, Michigan, since 1959. Beckman process chromatographs permit Dow to produce more ethylene, polyethylene, ethyl benzene, and ethyl benzene derivatives at reduced cost and at a consistently high purity level. ⌘ The four Beckman analyzers were chosen by Dow because of their rapid response, efficient analysis performance, reliability of operation, and minimum maintenance requirements. Two are located on distillation towers; another measures the effluent of the catalytic purification unit; the fourth is placed in the ethylene product stream to measure purity of end product. Precise parameter adjustments are made possible by 12 product readings taken from recorders located in a central operations building. ⌘ For more details on Beckman process gas chromatography write for Data File 14-6-07.

Beckman
Scientific and Process / Instruments Division
Beckman Instruments, Inc.
Fullerton, California

HOLD FINES TO A MINIMUM WITH JEFFREY CRUSHERS

Rolls on Jeffrey double roll coke sizers are fitted with renewable segments having thin, blade-shaped teeth. These provide a cutting action especially designed for handling coke. Sizing is surprisingly accurate and fines are held to a minimum. Whether you plan to size 8 tons per hour or 400 tons, there is Jeffrey equipment to handle the job — to pass a ¾-inch screen or through 4-inch openings. For help on coke sizing, get in touch with The Jeffrey Manufacturing Company, 912 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CHROMALOX
FIRST NAME IN ELECTRIC HEAT
Precisely controlled Radiant Heaters pre-heat plastic-coated paperforembossing without burning or scorching.
Six long Radiant Heaters form economical, highly efficient oven for curing extruded Teflon tubing.
Radiant heaters in hood cure centrifugally molded glass fiber reinforced torpedo tubes.
Ten radiant heaters automatically controlled for flexible, uniform vacuum forming.

EDWIN L. WIEGAND COMPANY
7514 Thomas Boulevard • Pittsburgh 8, Pa.
CHurchill 2-6400

At the turn of a dial...

CHROMALOX

ELECTRIC RADIANT HEATERS

fast, uniform, economical, safe

Here's high-intensity heat . . . adjustable from 0 to 100% of heating capacity by fingertip control. Different zones of heat intensity can also be set up . . . by arranging heaters in different "banks" with individual controls for each.

Chromalox Far-Infrared (long wave length) is absorbed almost equally fast by all colors, textures and surfaces . . . including clear glass, plastics, cellophane.

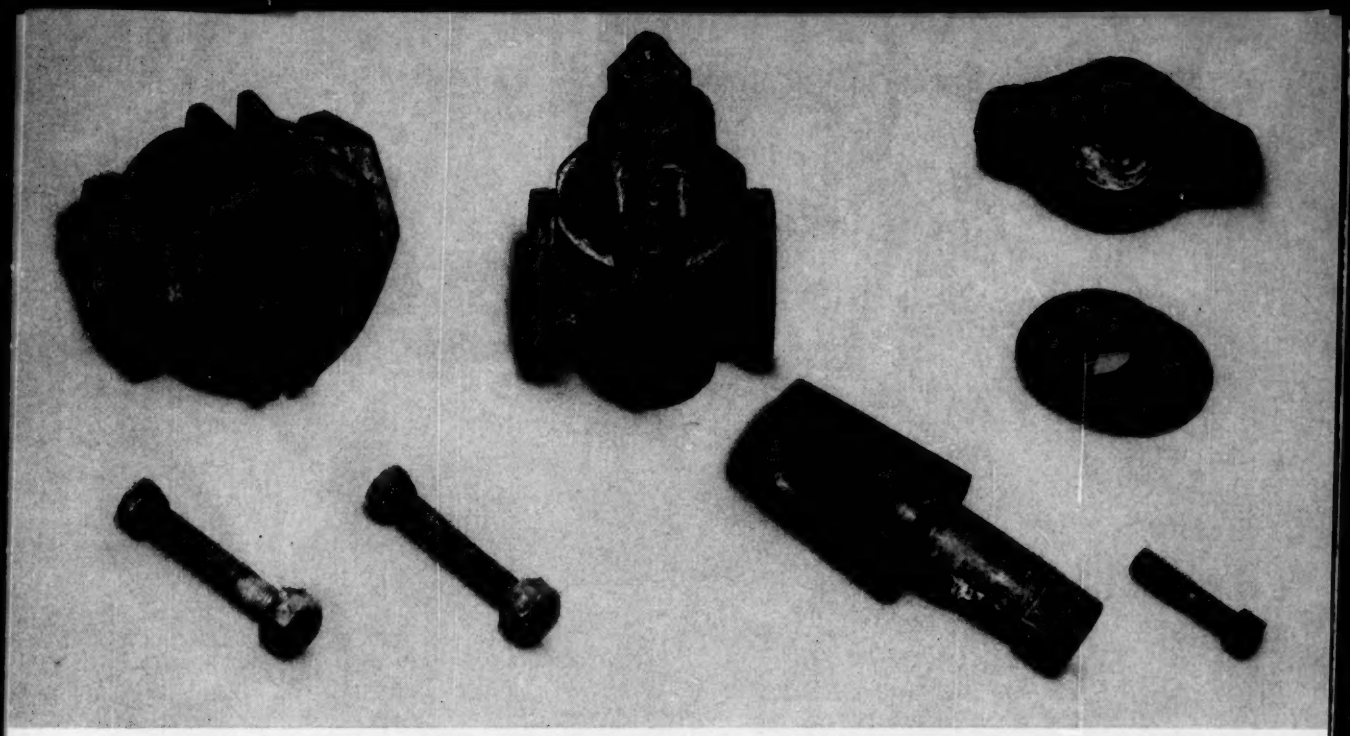
For heating, baking, drying, curing, pre-heating, dehydrating, pre-expanding.

Space-saving, non-breakable, all-metal units withstand knocks, bumps, vibration. Moisture-resistant terminals available. No fumes, flames, glare or leaky pipes. Standard heating lengths to 150 inches. Immediate delivery from stock. Low-cost installation and operation. You can build production line heating tunnels, ovens, banks right on the job.

Write for Bulletin G62. Or, for fast action and on-the-job assistance with your heating problem, call your Chromalox Man listed below. 91674

Call Your Chromalox Man for Heating Answers

ALBANY N.Y. Hobart 3-0626
ATLANTA GA. Trinity 5-7244
BALA-CYNWYD PA. Mohawk 4-6113 Greenwood 3-4477
BALTIMORE MD. Hopkins 7-3280
BLOOMFIELD N.J. Edison 8-6900 New York: Worth 4-2990
BOSTON, MASS. Cedar 5-8040
BUFFALO, N.Y. Summer 4000
CHARLOTTE, N.C. Edison 4-4244 Franklin 5-1044
CHATTANOOGA, TENN. Amherst 5-3862
CHICAGO, ILL. Harrison 7-5464
CINCINNATI, OHIO Trinity 1-0605
CLEARWATER, FLA. Phone 3-7706
CLEVELAND, OHIO Prospect 1-7112
COLUMBUS, OHIO Amherst 7-8260
DALLAS, TEX. Riverside 8-9004
DAVENPORT, IOWA Phone: 6-5233
DENVER, COLO. Glendale 5-3651 Genesee 3-0821
DES MOINES, IOWA Cherry 3-1203
DETROIT, MICH. (See Southfield, Mich.)
HOUSTON, TEX. Capitol 5-0356
INDIANAPOLIS, IND. Melrose 5-5313
KANSAS CITY, MO. Victor 2-3306
LOS ANGELES, CAL. Ludlow 9-6321
MIDDLETOWN CONN. Diamond 6-9606
MILWAUKEE, WIS. Broadway 1-3021
MINNEAPOLIS, MINN. Federal 6-6631
NASHVILLE, TENN. Cypress 2-7016
NEW YORK CITY, N.Y. (See Bloomfield, N.J.)
OMAHA, NEB. 341-7600
PHILADELPHIA, PA. (See Bala-Cynwyd, Pa.)
PITTSBURGH, PA. Emerson 1-2900
PORTLAND, ORE. Capitol 3-4197
RICHMOND, VA. Atlantic 8-8758
ROCHESTER, N.Y. Hamilton 6-2070
ST. LOUIS, MO. Chestnut 1-2433
SAN FRANCISCO, CALIF. Underhill 1-3000
SEATTLE, WASH. Main 4-7297
SOUTHFIELD, MICH. Kenwood 8-2100 Elgin 7-0677
SYRACUSE, N.Y. Granite 4-3933
WICHITA, KAN. Amherst 2-5647



Installed on caustic lines in 1930, these Rockwell-Nordstrom lubricated plug valves needed only cleaning before installation in new plant.

THE VALVES THAT WOULDN'T RETIRE

The Rockwell-Nordstrom lubricated plug valves shown above were two of dozens installed in 1930 on caustic lines at a process plant. When the plant was torn down in 1959, the valves were still in such good condition that they're being used on the same service in the new plant.

The above story is just one more example of the ruggedness of Rockwell-Nordstrom valves. Since they're sealed positively against leakage by pressurized lubricant and there are no exposed metal-to-metal seats, you get positive shut-off year after year. And, lubrication is preventive maintenance against the high cost of repairs, replacement and downtime. To get complete details on Rockwell-Nordstrom, the original and world's most complete line of lubricated plug valves, lubricants and accessories, write: *Rockwell Manufacturing Company, Pittsburgh 8, Pa.; Canadian Valve Licensee: Peacock Brothers Limited, Montreal, Quebec; Rockwell International S.A., Geneva, Switzerland.*

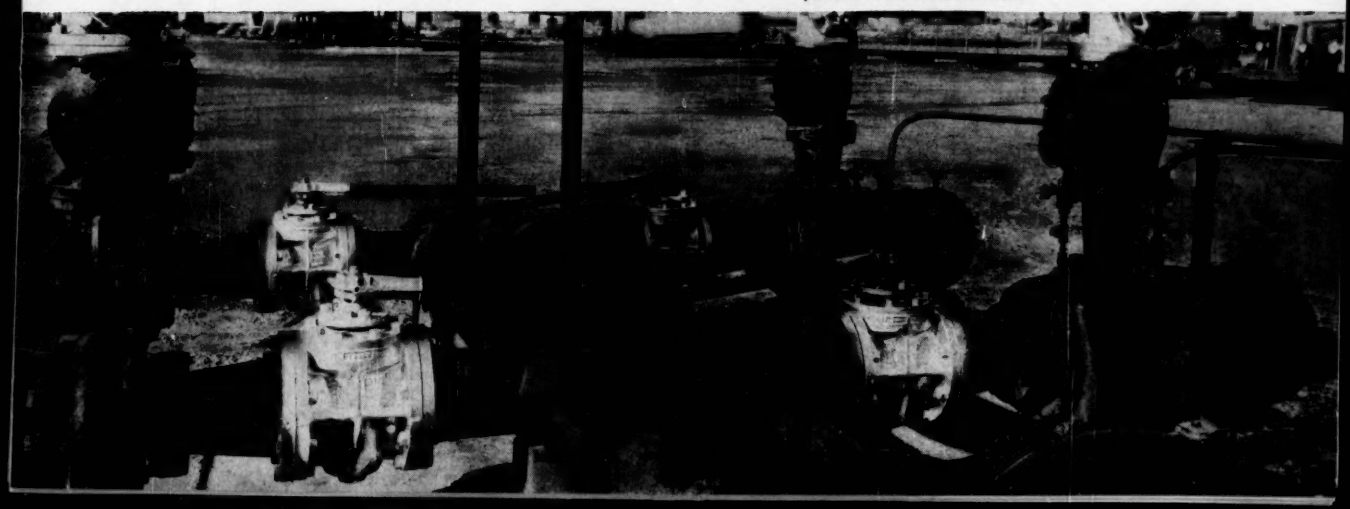
Lubrication Makes The Difference

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

On transfer pump service at large marketing terminal, these Rockwell-Nordstrom valves have already given 7 years of trouble-free service.



Virginia-Carolina: "Michigans a big factor in reducing costs"

Time and time again it's performance that counts . . . and that's why the list of fertilizer manufacturers who own Michigan Tractor Shovels is long and impressive.

Virginia-Carolina Chemical Corporation is a good example.

One of their typical plants—at East St. Louis, Illinois—owns three Michigans. Their most recent report says the following . . . "Our Michigans (it reads) have turned in *major* cost-reducing, production-boosting performances!"

The story starts in 1956. That year, of the nine sizes of Michigans available, Virginia-Carolina chose the 16 cu ft Model 12B. Two of them were bought from Michigan distributor Bardale Equipment Co, St. Louis . . . the Michigan no-foot-clutch, power-shift transmission and fully-sealed all-Clark power train considered major benefits over existing equipment. The success of these machines led, as production demands increased, to purchase, in 1958, of the third Michigan Tractor Shovel.

When the above picture was taken, the three Michigans had compiled a total of 23,100 working hours. Outside of a minor steering column failure, they had lost virtually no assigned work time.

Their assignment included (and still includes) handling of all kinds of material—superphosphate, muriate of potash, ammonium sulphate, and others. On a typical job—taking material from boxcars to conveyor hopper—one machine usually will make

about 40 shuttle trips an hour. The complete unloading task takes about two hours. Units also handle binned material, feed the batch scale, etc, etc. Loads range from 880 to 2,000 pounds each.

Lifting *capacity*, incidentally, of these 12B Michigans is 3,000 pounds. A wide range of buckets are available, 9 to 27 cubic feet. For still greater capacity, there's a new machine—also with two-wheel-drive—the 1 yd (standard bucket) Model 55B. Also available are seven job-proved *four-wheel-drive* Michigans, ranging from the 1 yd Model 55A to the Model 375A which handles buckets up to 10 cu yd capacity. Your Michigan Distributor will be glad to demonstrate any of them. Ask him anytime—see for yourself why firms like Virginia-Carolina, Agrico, Armour, Swift, International Minerals, Olin Mathieson, Smith-Douglass all buy—and repeat buy—Michigan fleets.

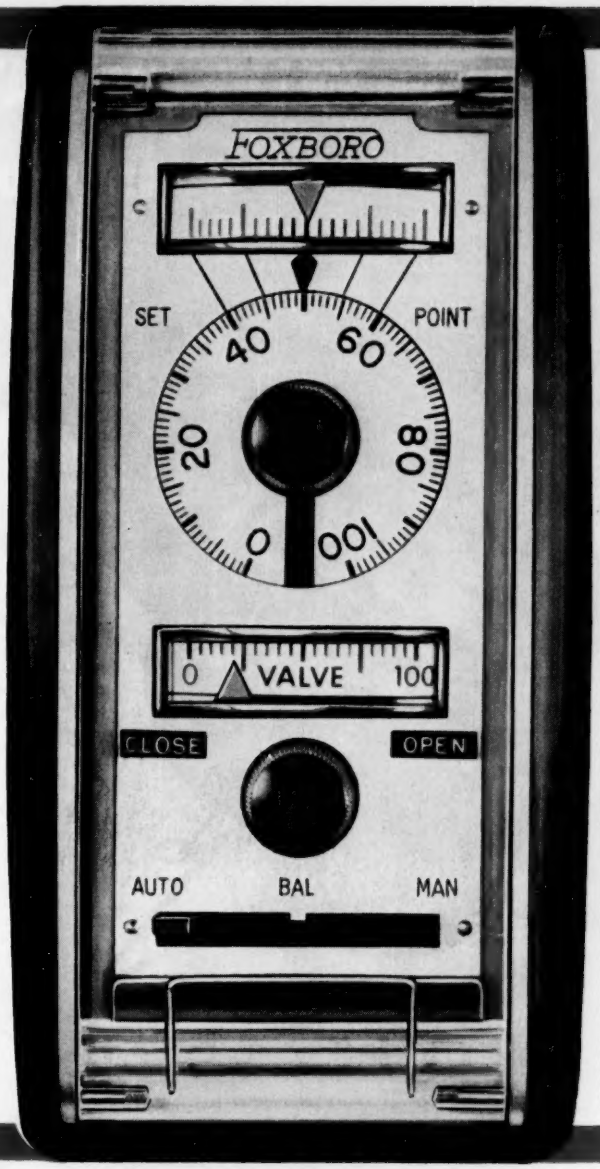
Michigan is a registered trademark of
CLARK EQUIPMENT COMPANY
Construction Machinery Division
CLARK EQUIPMENT
2477 Pipestone Road
Benton Harbor 20, Michigan
In Canada:
Canadian Clark, Ltd.
St. Thomas, Ontario

Measurement deviation...

plus indication...

plus valve position...

you get them all with this **Foxboro electronic control station**



Shown here actual size →

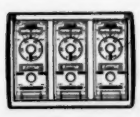
One 3" x 6" panel station containing all control and supervisory functions — that's the Foxboro Electronic Consotrol* Controller. All d-c input — all d-c output — all solid state. Operates completely independent from recording.

And look at these other features:

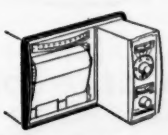
- measurement and deviation indicator gives continuous indication of process measurement as well as showing the deviation from set point.
- calibrated set point dial, with 4¾" scale, used with deviation indicator for readability of ½% full scale.
- valve position indicator for continuous, horizontal-scale indication of valve opening.
- simple auto-manual transfer switch for smooth, bumpless transfer.

Foxboro electronic Consotrol control stations are available for cascade, ratio and auto-selector systems. Ask your Foxboro Field Engineer about them — or write for **Bulletin 21-10. The Foxboro Company, 362 Neponset Avenue, Foxboro, Massachusetts.**

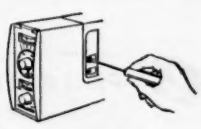
Reg. U. S. Pat. Off.



Standard 9" x 6" housing holds 3 control stations, or 1 station with a companion recorder.



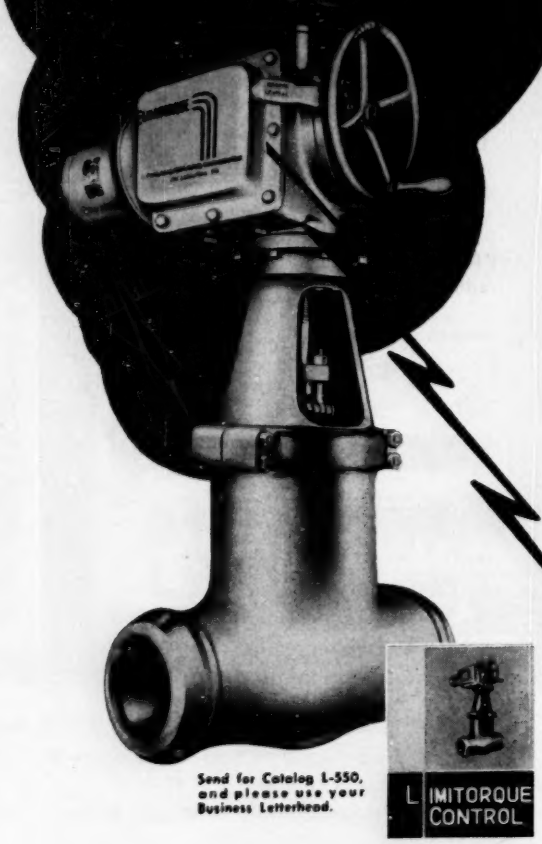
Controller and recorder each slide out from panel for easy servicing.



Proportional — reset — derivative: all adjusted from the front.

FOXBORO
REG. U.S. PAT. OFF.

the VALVE OPERATOR of the future is yours today...



LimiTorque

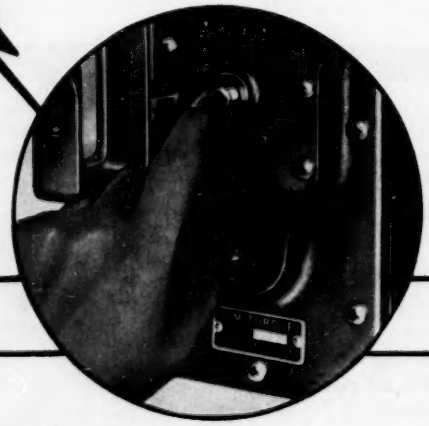
In keeping with this fantastic era of Rockets, Missiles, Jet Propulsion, Helicopters, Radar, Huge Power Plants on land and sea—LimiTorque is meeting and will continue to meet vital valve operating requirements . . . automatically, dependably, safely and economically.

Every important, necessary, and proven feature of automatic valve operation is available in *a type and size of LimiTorque designed and built especially for each individual service requirement:* LimiTorques that are operated by Electricity, Oil, Gas, Air, or Water; LimiTorques that operate valves at two speeds; LimiTorques that automatically take up contraction or expansion caused by temperature variations in the line; LimiTorques that are self-contained "packaged units"; LimiTorques that are equipped for proportional positioning in process control systems; LimiTorques for not only opening and closing valves, but for raising booms, transmitting linear motion, and closing bulkhead doors, etc.

Yes, LimiTorque, The Valve Operator of the *future* is yours *today* . . . and remember, LimiTorque is the most widely used Valve Operator in the world . . . it is backed by over 27 years continuous design and manufacturing experience.

Contact your Valve Manufacturer, or your nearest LimiTorque Sales Engineering Office.

Send for Catalog L-550, and please use your Business Letterhead.



Operates at the "mere push of a button"

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • King of Prussia, Penna.

Higher output on FINE GRINDING..20 to 400 mesh.. with WILLIAMS ROLLER MILLS

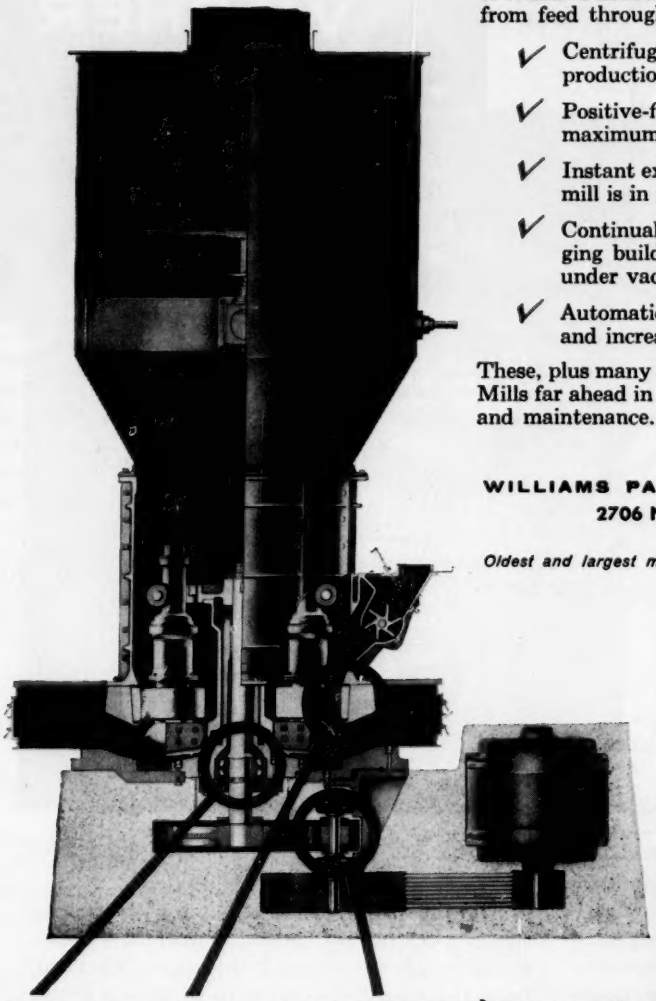
A Williams does the entire job in a single continuous operation—from feed through grinding, blending, drying and classifying!

- ✓ Centrifugal grinding roll action against bull ring keeps production high—automatically compensates for wear
- ✓ Positive-flow feed control is self-adjusting—maintains maximum capacity of mill
- ✓ Instant external fineness adjustment can be made while mill is in motion
- ✓ Continual upward air sweep to classifier prevents clogging build-up of finely ground material. Mill operates under vacuum to insure dustless operation.
- ✓ Automatically controlled hot air is available for drying and increased output of moist material.

These, plus many other advanced features keep Williams Roller Mills far ahead in higher production, lower costs. less downtime and maintenance. *Write for catalog.*

WILLIAMS PATENT CRUSHER & PULVERIZER CO.
2706 North 9th Street • St. Louis 6, Mo.

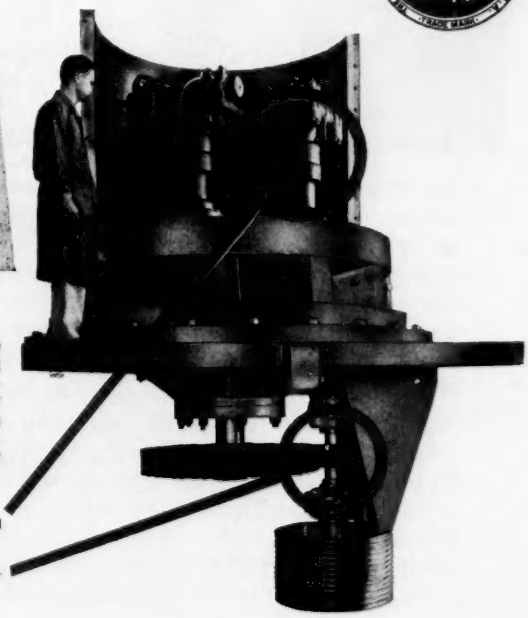
Oldest and largest manufacturers of hammer mills in the world



Troublesome alignment is greatly simplified and far less frequent with only 2 bearings on main shaft; the bottom one carrying both radial and thrust loads.

From here, material pulverized by rollers against bull ring are air-lifted to classifier which passes correctly sized product and returns coarse material for regrinding.

Exclusive! Only Williams has longer-life SPUR GEAR or GEARLESS DRIVES that eliminate expensive bevel and other hard-to-maintain gears. Standard and larger models have rugged spur gear and pinion drive—smaller models have direct motor-to-shaft V-belt drive requiring no care or lubrication.

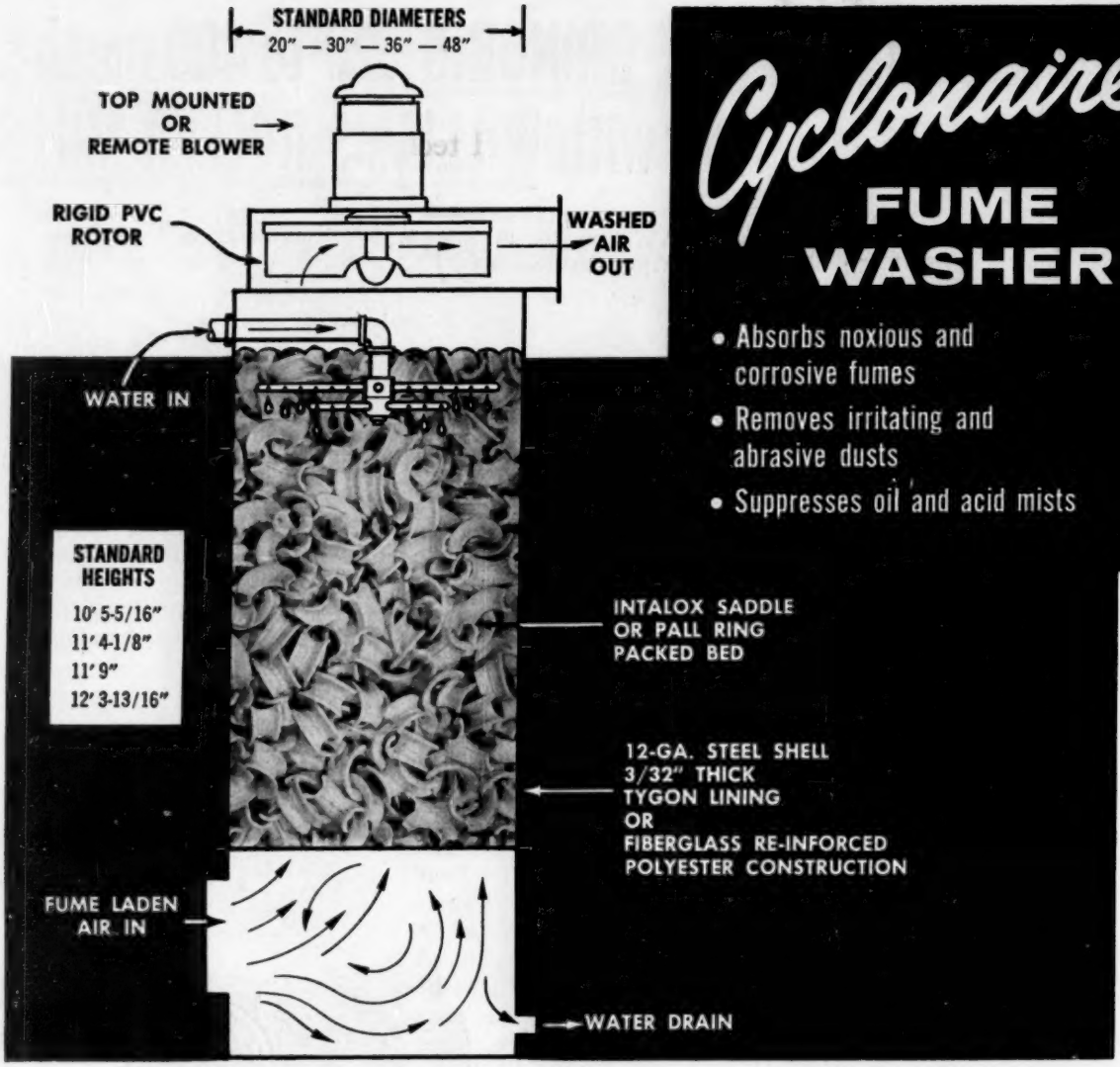


"Giant" mill with cover section off show roller journals which suspend grinding rolls on bearings sealed against dirt and grit. Note wear-resistant steel forged bull ring.

Housing is also removed to show rugged spur gear and pinion drive. Easy, quick accessibility for service is another Williams time and money-saving feature.

WILLIAMS
CRUSHERS GRINDERS SHREDDERS

Hammer Mills | Helix-Seal Mills | Air Separators | Vibrating Screens | Feeders | Impactors



The "Cyclonaire" is a surprisingly compact wet bed scrubber. It will fit almost anywhere, but it does a fume removal job formerly possible only with expensive custom-designed units. Removal of many gases (of 1% concentration or less) is up to 99% effective. Low power requirements make it very economical to operate.

The "Cyclonaire" is available fabricated either from 12-gauge steel, lined with 3/32" thick Tygon sheet plastic, or from fiberglass re-inforced polyester resin. The lined-steel unit comes complete with a top-mounted blower equipped with a rigid polyvinyl chloride (PVC) rotor. The lighter weight fiberglass re-inforced polyester unit utilizes a separately mounted blower duct-connected to the unit.

Both units are shipped complete with the necessary packing — Intalox porcelain saddles, metal or poly propylene Pall Rings—depending upon the corrosive conditions or weight limitations existing.

The "Cyclonaire" is available in four sizes with rated capacities of 750, 1650, 3500 and 6000 cfm.

Its low initial cost, its low operating cost, its high efficiency make the "Cyclonaire" a logical choice for a wide range of fume scrubbing operations. Full technical data in Bulletin FW-10R. Write for it today.

PROCESS EQUIPMENT DIVISION

U. S. STONEWARE

NEW YORK • LOS ANGELES • HOUSTON

AKRON 9, OHIO

376F-3

Top news stories and what they mean to CPI technical decision-makers

Chementator

New acid-gas scrubbing process is coming; uses cheapest absorbent

Countering the trend towards exotic solvents used in the newer acid-gas scrubbing processes (e.g., Fluor and Giammarco-Vetrocoke flowsheets), Germany's Friedrich Uhde Gmbh. (Dortmund) is about to offer a process that uses the simplest of all solvents: water. *CE*'s Bonn bureau reports that the most likely first user of the Uhde process is a large (unidentified) European petrochemical company that has become disenchanted with a variety of chemical schemes for cleaning its 15% CO_2 and 15% H_2S natural gas stream.

Uhde's only qualification about water's suitability: the natural gas to be treated must run higher than 10% CO_2 and over 8-atm. pressure. When this is the case, water scrubbing requires lower capital investment and operating outlays than even the least exotic of the chemical solvents—hot potassium carbonate.

Advantage of water scrubbing is that water's absorption capacity increases with pressure while most chemical solvents are limited by chemical composition. Above the stated breakpoint, the volume of water needed is low enough so that equipment size and utility requirements are pared below that of any other system.

Water scrubbing of acid gases isn't a new idea, and Uhde readily concedes its process is based on modifications of the classical flowsheet. The firm is not ready to describe all of its improvements but indicates that two of the features involve cutting down dissolved-methane losses and improving the method of removing hydrogen sulfide from the water stream.

Process swallows surplus HCl by using it to chlorinate methane

Du Pont is now operating a pilot plant at Orange, Tex., that uses HCl, instead of the usual chlorine, to chlorinate methane, according to reliable industry sources. If the process proves practical, it will be of great value in the Southwest because of the excess of HCl generated by the host of chlorinating operations there. Du Pont's process, in effect, bypasses the chlorine-from-HCl routes that are being developed by several firms.

In the pilot unit, HCl mixes with natural gas and oxygen, then passes into a brick-lined fluidized-bed reactor. First occurrence in the reactor is a modified Deacon reaction where the oxygen reacts with HCl to form free chlorine, which in turn reacts with the hydrocarbons. Product distribution is about 40% carbon tetrachloride, 40% chloroform, 15% methylene chloride and 5% methyl chloride. Key to successful operation of the process is a cheap source of oxygen, a secret catalyst, and the solution of some severe corrosion problems.

Du Pont's work is said to be based on investigations of methane chlorination with HCl conducted by H. P. Meissner and E. F. Thode at Massachusetts Institute of Technology, which was published ten years ago. In that original work, a copper chloride catalyst was used, with temperatures of 750-1,020 F. and atmospheric pressure. Conversions of HCl as high as 90% and methane conversion as high as 40% were obtained.

Du Pont will not confirm the above reports, will only say that its Electrochemicals Dept. is "studying several methods of chlorinating hydrocarbons."

Butadiene fathers a new family of cyclic C-8 petrochemicals

A process to produce a whole new class of eight-carbon petrochemicals has been developed by Cities Service Research & Development Co. Among the compounds that the firm is turning out in a 50,000-lb./yr. plant at Lake Charles, La., are cyclo-octadiene, cyclo-octene and octanedioic (suberic) acid. These materials are expected to find use in such products as nylon 6,6

Now! The LUNKENHEIMER BALL VALVE

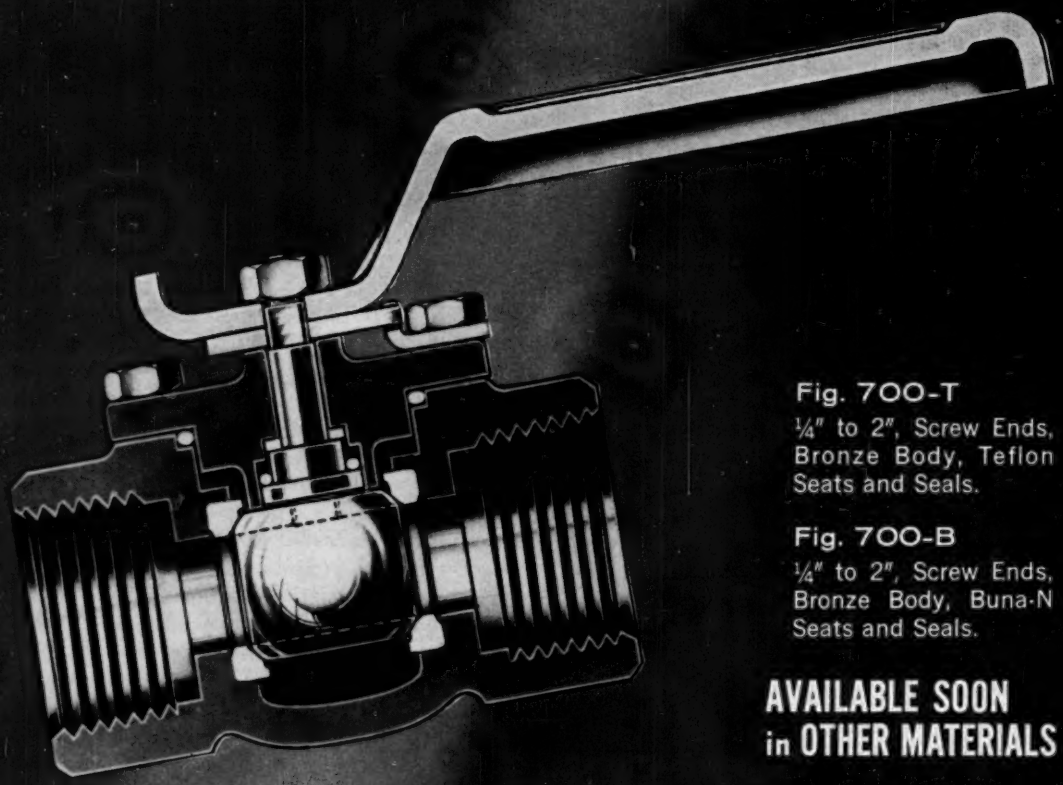
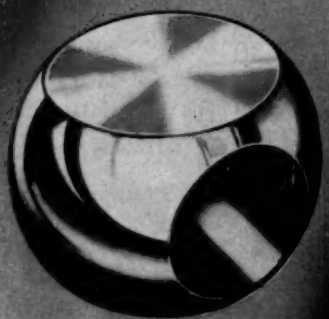


Fig. 700-T
¼″ to 2″, Screw Ends, Bronze Body, Teflon Seats and Seals.

Fig. 700-B
¼″ to 2″, Screw Ends, Bronze Body, Buna-N Seats and Seals.

AVAILABLE SOON in OTHER MATERIALS

New Top-Entry Design



Engineered with traditional Lunkenheimer quality . . . self-aligning ball seals against both seats . . . long-lasting resilient seats for tight shut-off . . . straight-through flow . . . quarter-turn operation . . . top entry for easy maintenance

or write The Lunkenheimer Company, Cincinnati 14, Ohio

L-960-3

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES
• BRONZE • IRON • STEEL • PVC

(suberic acid can replace adipic), adhesives and coatings (e.g., diepoxide of cyclo-octadiene), and synthetic lubricants.

Cities Service will say little about the process except that it starts with butadiene, uses a secret catalyst, employs moderate temperature and pressure in "conventional equipment" to give "high yields." All compounds, including by-product vinyl cyclohexane, are being sold in drum quantities at a development price of 50¢/lb. Firm will not branch into end-product manufacture itself but hopes to stimulate demand for the intermediates among other chemical manufacturers.

Other companies are showing varying degrees of interest in these new cyclic compounds. Texas Butadiene & Chemical, for example, has been experimenting with C-8 compounds (using Ziegler catalysts) and has just completed a market study on suberic acid. All it will say about its findings is that suberic is a "pretty interesting chemical." And there is considerable interest in cylic C-8's in Germany, where researchers are trying to use acetylene as the building block. But there has reportedly been difficulty synthesizing suberic-like compounds via oxidation-cleavage reactions, using standard oxygen, ozone or nitric acid oxidants.

Petro-Tex, which has been in the C-8 business for three years with its diisobutylene, says that it has no plans at the moment to manufacture cyclic C-8's.

New freeze-desalting process to get tryout in commercial plant

Adding to the mounting activity in the desalination field, Fairbanks Morse & Co. announces that it will build, in cooperation with the Israel Ministry of Development, a sea water desalting plant at Elath, Israel, on the Gulf of Aqaba. Facility, to be completed by the end of '61, will have a capacity of 250,000 gal./day, and it is claimed that it will "provide fresh water at a lower cost than ever achieved in sea water conversion, probably around 40¢/1,000 gal."

Plant will consist of four machines, based on a process developed by the Israeli scientist, Dr. Alexander Zarchin. First production unit has been completed and is now being tested at Fairbanks' plant in Beloit, Wis.

Although few details about the process have been revealed, Fairbanks says that it operates at high vacuum, uses no working fluid (which is called for in some of Zarchin's patents). Based on Zarchin's previous statements, it's probable the plant will operate like this: sea water is chilled by heat exchange with fresh water product, then sprays into a low-pressure chamber. Part of the water flashes and leaves overhead, causing the remaining water to freeze.

Ice crystals flow into a horizontal chamber and drop onto a traveling screen, with brine draining off. Overhead vapor from the flash chamber is then compressed and fed to the second chamber, causing the outer surface of the crystals to melt, thereby removing the last traces of brine. Ice crystals flow to a melting vessel, and the melted ice along with the spent brine helps cool the entering sea water.

The Ministry of Development plans to start production of desalting equipment in Israel as soon as possible. It will announce early in March, along with Fairbanks Morse, plans for worldwide marketing of the desalting units.

As predicted earlier (Chementator, Oct. 17, 1960, p. 83) Dow and Stauffer have reached an out-of-court settlement of the patent infringement suit involving chlorinated solvents. Stauffer will now be licensed under Dow's patents and Dow will receive royalties of about $1.5 million.

Atom test would turn salt dome into a petrochemical plant

Some south Mississippi pine land may soon be turned into an unusual petrochemical source. The director of Mississippi's Industrial & Technological Research Commission has announced that a $20-million atomic test is planned in that state, assuming that a suitable agreement can be reached with the Soviet Union regarding peaceful explosions.

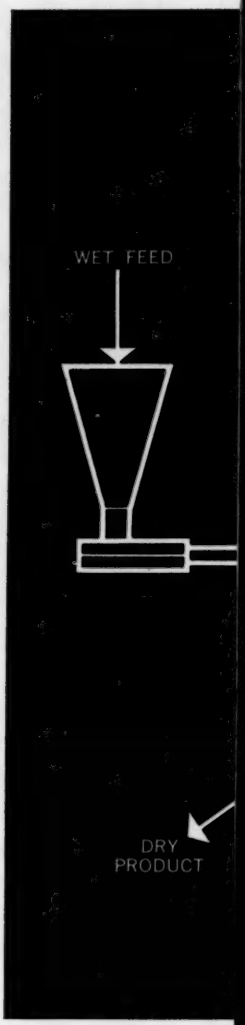
Aim of the proposed test is threefold: (1) to prove that atomic explosives can be safely used in excavating. Specifically, it is hoped that these explosives can chop 10% off the estimated $300-million cost of the Tennessee-Tombigbee waterway now under consideration. (2) To prove that heat from atomic blasts can be stored

(continued on page 38)

AN EFFICIENT NEW TECHNIQUE FOR

Another development of the versatile

DORRCO® FLUOSOLIDS® SYSTEM



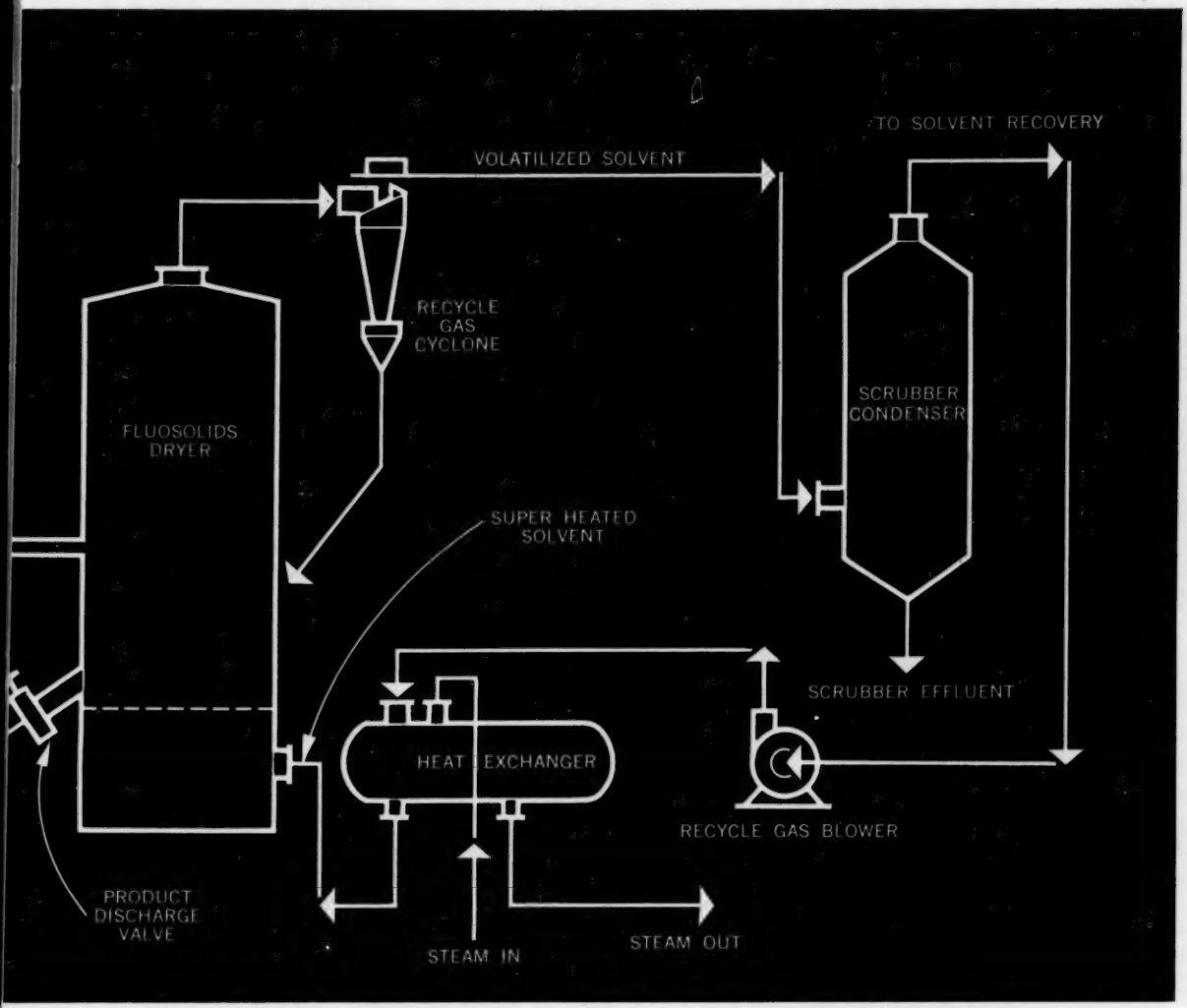
Application of the Dorrco FluoSolids System to the drying of heat-sensitive materials containing recoverable volatile solvents brings a new and highly efficient technique to the plastics industry. Typical materials that can be handled include polyvinyl chloride, polystyrene, polycarbonates, polyethylene, polypropylene, and polyvinyl alcohol.

Drying is accomplished in a fluid bed where the solvents are volatilized. Heat is provided by superheating the solvent and recycling it to the fluid bed. No separate gas generator is required. The system provides for complete recovery of the valuable constituents contained in the feed with the minimum of equipment. Ease of sealing against loss of solvent is a special feature. With no moving parts, seals are not required. Product cannot be contaminated by sealing compounds.

Outstanding advantages are the efficient and easily controlled drying conditions obtainable with the FluoSolids technique, low space requirements, low maintenance and minimum need for labor. Start up and shut down is fast and safe. Instrumentation is easily applied for automatic operation. Power and heat requirements are low.

Proof of successful operation has already been provided in an important installation which is now onstream. Design capacity was reached almost immediately, with a minimum of operational difficulties. Valuable experience accumulated by Dorr-Oliver engineers offers an effective basis for future recommendations. For information and estimates on complete drying systems engineered to meet your particular conditions, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

DRYING HEAT-SENSITIVE PLASTICS



FLOWSHEET OF TYPICAL INSTALLATION

Wet feed is supplied continuously from bin by screw feeder to the FluoSolids Dryer, where preheated recycled solvent vapors fluidize and heat up the incoming material to the desired temperature. Finished dried product is removed through an automatically operated discharge valve. Any finely divided dust carried out in the gas stream is collected in the gas cyclone and returned to the dryer fluid bed.

Volatile gases after passing through the cyclone are sent to the scrubber for final solids removal. Gas leaving the scrubber is metered and passes through a flow control valve prior to entering the recycle gas blower for compression. Gas then enters the steam heat exchanger and is supplied in superheated form to the windbox of the dryer.

Simplicity of the system is illustrated by the fact that the only prime mover is the gas blower. The complete drying system is supplied by D-O. It may be altered to meet specific conditions.

This FluoSolids system was installed in a new plastics plant designed by Crawford & Russell Incorporated, Chemical and Process Plant Engineers, 7 Market Street, Stamford, Conn.

DORR-OLIVER
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

underground for later use in generating power. (3) To see whether heated salt domes can be used as giant reactors for large-scale cracking of petroleum feedstocks.

Test plans have been mapped out by the AEC's Livermore, Calif., laboratory. According to its estimates, a penny's worth of petroleum residuum could be converted into 10-15¢ worth of petrochemicals in the heated salt beds, 2,500 ft. below the surface. The AEC has already leased 1,400 acres just south of Hattiesburg, Miss., for the tests. It estimates that it will take 18-20 months to dig the mine shaft and place the test explosives, once the Soviet-U. S. ban on peaceful nuclear tests is lifted.

Japan Chemical Salt Co. and Asahi Glass are operating the first salt-from-the-sea electrodialysis plant on island of Shikoku. Plant will produce 10,000 tons/yr. salt at lower cost than solar evaporation. Ionics, Inc., is running a similar pilot plant in Japan in cooperation with Asahi Denka.

Antitrusters on a new tack—start scrutinizing joint ventures

Dept. of Justice trustbusters are starting to examine more critically the concept of the joint venture, which has become increasingly popular —especially in the chemical industry—as an avenue of corporate growth. A suit filed by the government early this year against Pennsalt, Olin Mathieson and their newly created Penn-Olin Chemical Co. marks the first use of the Clayton Antitrust Act against a jointly owned subsidiary.

This growing popularity of joint ventures was what caught the Justice Dept.'s eye, according to a spokesman queried by *CE*. He went on to say that there seems to be a correlation between the success of the department's activity against mergers and the rise of joint ventures. It is possible, he said, that this new form of corporate cooperation is being used to attain what mergers formerly had sought to accomplish.

The suit against Penn-Olin specifically charges restraint of trade in sodium chlorate (the product will be made in a new Penn-Olin plant at Calvert City, Ky.). Pennsalt is already a major producer, and Olin Mathieson a leading consumer, of sodium chlorate.

Pennsalt retorts that "since the announcement of the $6.5-million Penn-Olin venture, other producers of sodium chlorate, anticipating increased competition, have announced expansion plans and marketing concessions." Firm says it will vigorously contest what it terms "this threat of new restraints by the government at a time when there is great national need for accelerated industrial growth."

Westinghouse has delivered a 100-w. thermoelectric generator to Northern Illinois Gas Co. for use at a remote pipe line pumping station. Unit will provide current for cathodic protection and for charging batteries of a microwave relay system.

Computer control: another yes vote—along with one dissension

Gulf Oil Corp. has declared itself among the growing ranks of companies investing in process control computers. Gulf reports that it will have its 60,000-bbl./day fluid catalytic cracker at its Philadelphia refinery under closed-loop computer control early this year. This is believed to be the first such installation on a cat cracker (Stancal's El Segundo, Calif., refinery has a cat cracker under open-loop control).

Gulf is using a Thompson Ramo Wooldridge RW-300 computer, with about 150 analog and digital inputs. Firm is also installing end-point and process-stream analyzers to provide up-to-the-minute information to the control system. Gulf expects to boost cracking efficiency to 95% of theoretical, mainly through closer control of reactor temperature and recycle ratio.

But speaking out against the current untempered enthusiasm for computer control was American Cyanamid's Herbert Grohskopf at a recent meeting of the New York section of AIChE. He maintained that there is too much emphasis on gadgetry and not enough on advancement of basic process understanding. He cited a major process study that Cyanamid has done on one of its continuous process units. The firm was able to achieve a 30% capacity increase, with a capital cost saving of 25%, by intensive

For more efficient sulfations and sulfonations

99.5% available SO_3

GENERAL CHEMICAL

SULFAN®

General Chemical SULFAN offers you many significant advantages—in use, in service, in supply.

The unique form and properties of SULFAN—99.5% available SO_3 in easy-to-handle liquid form—enable you to step up operating efficiency, to run larger batch sizes, and to get more rapid through-put . . . often *double* in the same equipment. No spent acid disposal problems, either!

You also get the benefits of General's 10 years of experience with stabilized SO_3, for all types of application. Our technical service specialists can really show you where, when and how to cash in on SULFAN for *your* operation.

A further and not inconsiderable advantage you get with SULFAN is dependability of supply. As the only supplier of stabilized sulfur trioxide with multiple producing locations, General Chemical can provide better service... assurance that your schedules can be met!

Learn more about SULFAN now. A letter outlining your particular requirements will bring information of immediate practical value! Or mail coupon for free technical brochures.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

Mail coupon now for free technical brochures on SULFAN!

GENERAL CHEMICAL DIVISION
Allied Chemical Corporation
40 Rector Street, New York 6, N.Y.

Please send free copies of "Reactions of Sulfur Trioxide," and "Sulfan."

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____

State_____ CE-21

study of process kinetics. In the low-temperature gas-purification system, for example, a 30% increase in refrigeration capacity was obtained by a few piping changes. This was accomplished, Grohskopf said, by a combination of plant-scale experiments and off-line computer simulation—and without resorting to expensive computer control hardware.

Process for separating pure amylose and amylopectin from ordinary dent corn has been announced by A. E. Staley Mfg. Co. Firm has a pilot plant operating at Decatur, Ill., fractionating the two basic starch components in semicommercial quantities and in "reasonable degrees of purity."

Plastics crack building codes; to replace oft-broken window glass

A slow-growing but potentially sizable market is developing for methacrylates (e.g., Plexiglas and Lucite) as building codes are softened to permit the plastic to replace glass in public and private buildings. Leading example: a Brooklyn school, whose windows were frequently a target for rocks, is switching to plastic windows to make the building less vulnerable to attack.

Methacrylate windows are claimed to be not only more resistant to impact than glass, but also in the event that a severe blow breaks a window, the pieces are dull edged, less likely to cause injury.

Another use: in public buildings where skydomes are coming into prominence. Consisting of a hemisphere of translucent plastic with a square base (up to 8 x 8 ft.), the skydome is said by plastics makers to admit less heat from the sun than is generated by fluorescent lights delivering an equivalent amount of light.

Methacrylates are also invading the prefab field, replacing metal in sandwich walls. Principal advantage: panel surface characteristics of texture and form are easily produced with a simple plywood mold, vs. elaborate dies needed to stamp out metal panels. Plastic sheets, sandwiched around fiber glass or polystyrene insulation, are strong enough to serve as load-bearing structural members.

Unfair labor practices may void engineering union decertification

The decertification of the Engineers Assn. at Sperry Gyroscope Co. (*Chementator*, Oct. 3, 1960, p. 35) will be reviewed by the National Labor Relations Board later this month. The issue: the union's charge that the company encouraged the dissident engineers (who called for the decertification vote) with time off and campaigning funds. If the union's charges are upheld, it is possible the decertification could be set aside, which could bolster engineering unionism after recent setbacks (see p. 118).

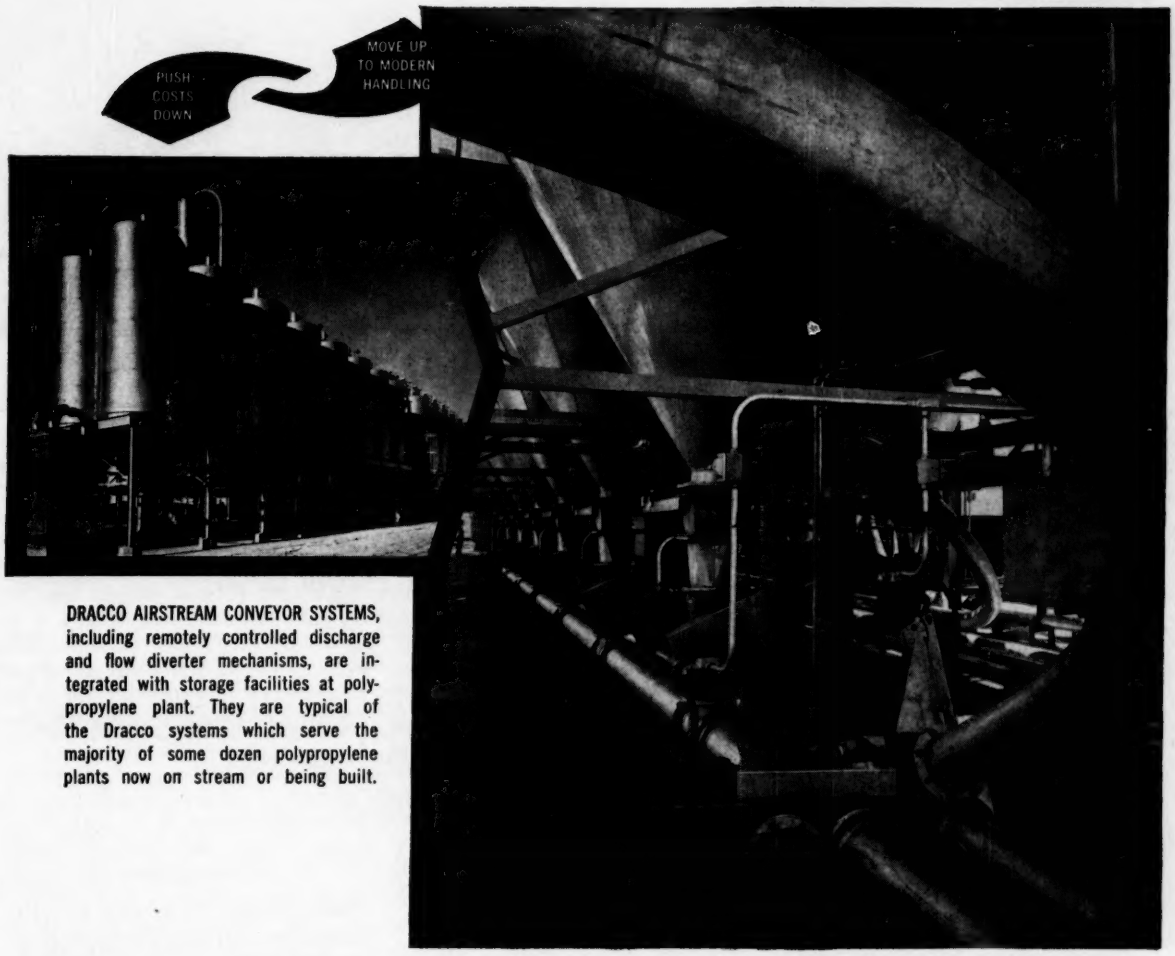
Here is the background: soon after the election results were known, the union lodged a complaint with the NLRB about the company's role in the vote. NLRB's regional board investigated and reportedly found that Sperry had interfered illegally in the election.

After the investigation, the NLRB regional director entered into an "informal agreement" with the company, in which Sperry agreed that it would not, in the future, organize or support a decertification group. The Engineers Assn. immediately objected to the agreement on the grounds that it did not provide any relief for the damages the union had allegedly suffered. NLRB's general counsel subsequently upheld the union's protest and is scheduling a new hearing to look into the whole conduct of the vote.

Research and development briefs

Linseed-oil, water-based paints are being intensively studied by U. S. Dept. of Agriculture researchers at Peoria, Ill. Formulations developed so far are readily diluted with water, but resist water within 15 min. after application and are dry enough in 30 min. to apply another coat. Tests show that the paints adhere well to chalking surfaces and have good covering and flow properties. Some of the paints have remained stable on the shelf more than 46 weeks.

For More Industry News . . . 42



DRACCO AIRSTREAM CONVEYOR SYSTEMS, including remotely controlled discharge and flow diverter mechanisms, are integrated with storage facilities at polypropylene plant. They are typical of the Dracco systems which serve the majority of some dozen polypropylene plants now on stream or being built.

handling polypropylene

. . . a job for specialists in air conveying

Polypropylene is trying to crack the highly competitive plastics market. Success depends on lowering production costs through advanced methods and equipment such as automatic, through-process bulk handling.

Handling polypropylene is a Dracco specialty, developed through unequaled experience in air conveyor engineering for producers of other petrochemical-based plastics. For example, some 80 per cent of the nation's polyethylene plants are equipped with Dracco Airstream Conveyor Systems. Now, most polypropylene producers are looking to Dracco for bulk handling as modern as their new product.

Dracco engineers are at home in the special areas of knowledge required for a true "systems" approach to bulk handling problems in these plants. This is applied in comprehensive conveyor networks that can move materials from dryers through process to storage and bagging or bulk loading.

Low-cost, programmed handling is accomplished with centralized automatic control. Materials flow smoothly on an enclosed stream of filtered air or inert gas . . . without dust, waste, discoloration or contamination. Systems may be expanded easily, with minimum engineering, when handling requirements increase.

Why not place *your* bulk handling problems in the hands of specialists? Call or write: Dracco Division of Fuller Co., Harvard Avenue & East 116th Street, Cleveland 5, Ohio.

See Chemical Engineering Catalog for details . . . or write for 32-page Bul. 530, "Dracco Airstream Conveyors."

DRACCO *airstream* conveyors
dust control equipment

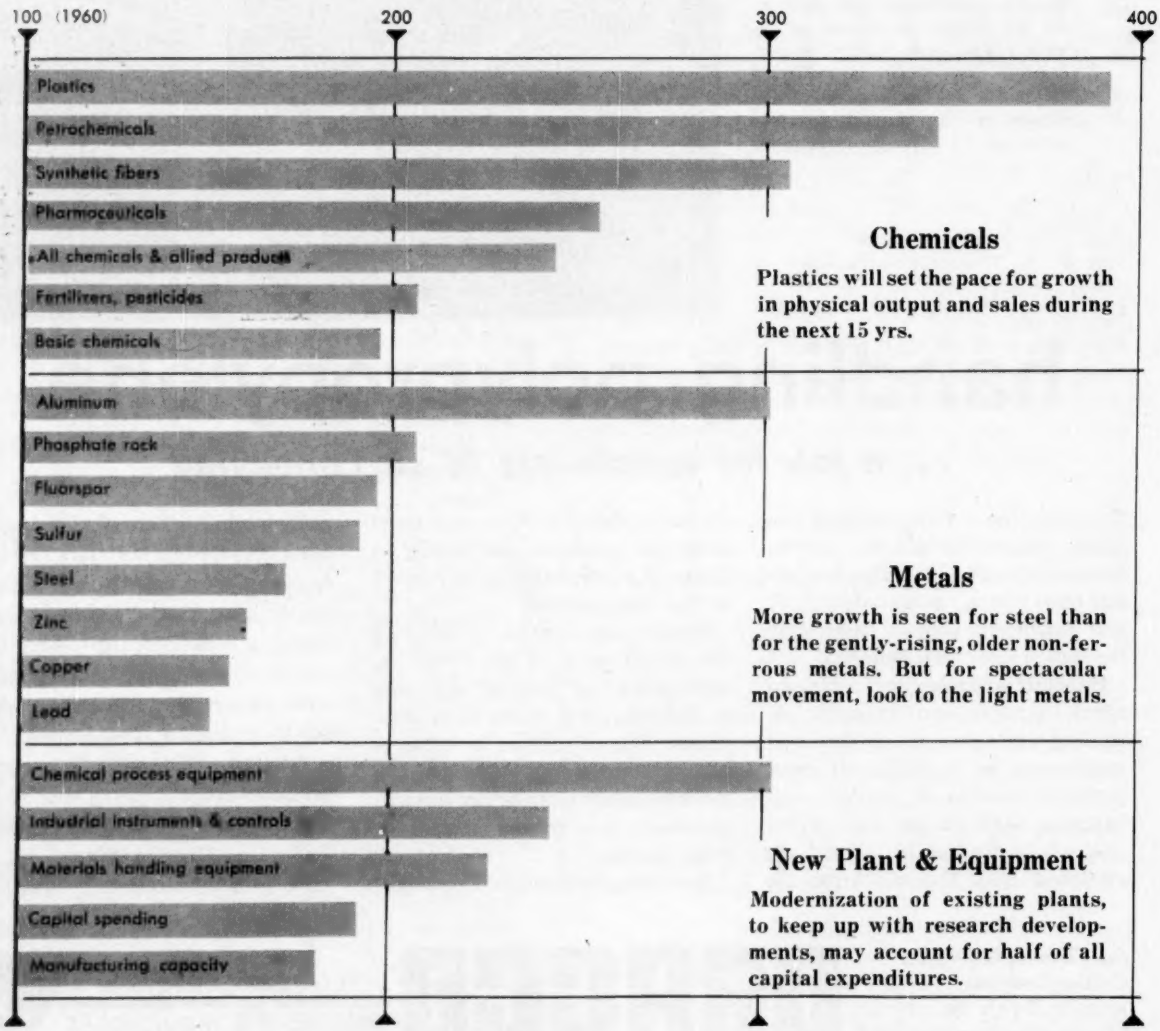
FULLER COMPANY GENERAL

CPI: TWICE THE SIZE IN...

New 15-yr. outlook study shows chemicals and allied products growing at a rate well above the national average, to more than double '60 sales of $27.8 billion.

The direct link between research and development and America's future growth is a major theme of a new study conducted by the Mc-

More angles on the future: percents of growth to '75



Graw-Hill Dept. of Economics. The study explores prospects for growth through 1975, appraising present and foreseeable business forces.

By 1970, total expenditures on R & D will reach an estimated $23 billion. In the past 15 years, the total has climbed from less than $2 billion/yr. to nearly $13 billion.

▶ **Growth Key: R & D**—The result of all this research and development work has been to create new products and new industries. For example, in the past decade, output of plastics is up 300%; electronics production is up 240%; aluminum output has increased 200%. Even companies in such well-established fields as food processing have close to 30% of their present sales in product lines developed since '50.

▶ **Hardest Impact's Ahead**—But the greatest impact of new products and new processes, for an expanding market, is expected about '65—reflecting the step-up in research spending that began in the mid-'50s. And by '75, the use of aluminum, for example, may triple; output of plastics, nearly 6.5 billion lb. in '60, should approach 25 billion.

There will be tremendous demands for modernization of existing plants to keep up with research developments. Businessmen answering a recent McGraw-Hill survey revealed that it would cost $95 billion to replace all obsolete facilities with the best new plant and equipment. So, over the long run, replacement and modernization expenditures may account for half of all capital investment.

▶ **For CPI Plant**—Bright growth prospects for the chemical industry indicate a large demand for chemical process equipment. Makers of such equipment will also benefit from the trend toward greater utilization of byproducts and chemical wastes in such industries as steel, petroleum, pulp and paper. And the need for chemical processes to utilize low-grade mineral ores and improve the qualities of other natural materials such as textile fibers and lumber, will add to the market for equipment of this type. Thus, production of chemical process machinery may triple by '75.

▶ **For Chemicals**—Total production of chemicals is expected to rise 140% by '75. Growth in some lines will greatly exceed this average. The future for plastic materials is particularly bright. Among the big uses that lie ahead: in homes—walls, ceiling and furniture; in industrial plants—pipes, dies and heavy bearings; in consumer goods—auto body parts and housings for large appliances.

Most industrial chemicals will track along with the general growth in industrial production, but the sharpest rise within this group will be in synthetic organic chemicals. And among these, petrochemicals will stand out. By '75, about 75% of all synthetic organics will be made from oil and gas. (Not long ago it was 25% from petroleum sources and 75% from coke oven byproducts). By '75, output of petrochemicals may easily be up 240%.

As for metals, such old standbys as copper, lead and zinc are expected to sustain an average growth in consumption of 50 to 60% over the next 15 yr. There will be more growth in steel, especially alloy steel. As machines run faster, more and better alloys to stand greater stress and heat will be needed. This means a more than proportionate rise in consumption of the valuable alloying elements such as columbium, molybdenum, rare earths.

▶ **Light-Metal Spectacular** — The really eye-popping growth will be in light metals. Magnesium production may increase 300% in the next 15 yr. As much aluminum as went into all uses in '60 may go into the building industry alone in '75. It is the preferred material for doors, window frames—even entire walls. And aluminum makers expect to see a tremendous increase in the use of the white metal by the auto and pleasure boat industries.

Domestic passenger car production in '75 is likely to reach 9 million units compared with 6.7 million units (not all of which were sold) in '60. By '75, there may be a substantial market for personal planes—the next major step forward in consumer transportation.

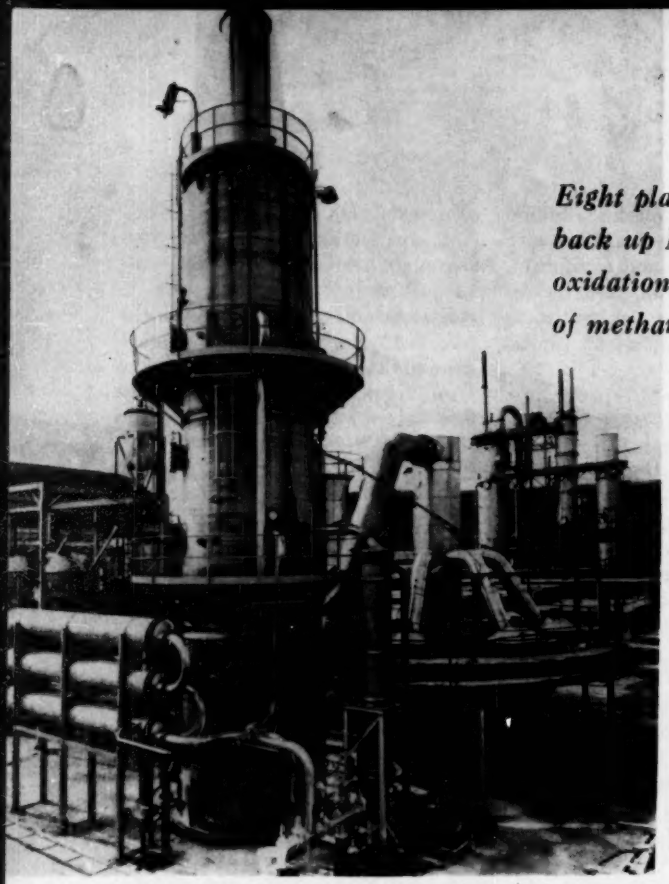
From '30 to '60, the nation's productivity increased by an average of 2.5%/yr. We have done better than this during the 15 yr. since the end of World War II. With continued improvements in research, education and capital goods during the '60s and '70s, there is hope that average national output/man-hour—key factor in projecting growth—will increase at a rate of 2¾%/yr., midway between the rate of the last 30 yr. and the postwar rate.—FA

Giant Fertilizer Complex Slated for the South

Armour Agricultural Chemical Co. is tripling its capacity for making nitrogen and phosphate fertilizers with one of the largest grassroots fertilizer projects ever started. On completion of the $60-million program in 1962, Armour's investment in chemicals will equal its stake in the food business.

Major part of the design and construction has been divided among four firms. M. W. Kellogg will erect a 360-ton/day ammonia plant and 50-ton/day Montecatini urea plant near Cherokee, Ala. Chemical Construction Corp. will build an adjacent ammonium phosphate plant. Chemical & Industrial Corp. will build a nitric acid plant, a 240-ton/day nitrogen solutions plant and a 250-ton/day ammonium nitrate prills plant at the same site.

Chemico will build a phosphoric acid and triple superphospate plant in Polk County, Fla., Titlestad Corp., a sulfuric acid plant.



Eight plants completed, or planned, back up Montecatini's claim that its new catalytic oxidation technique produces higher yields of methanol-free formaldehyde.

Fourth unit at Castellanza (foreground) has 40,000 tons/yr. capacity. Methanol-air mixture enters reactors (right) through curved pipes, formaldehyde is absorbed in water in large tower (center).

ITALIAN $\begin{matrix} H \\ H \end{matrix}\!\!>\!C{=}O$ ROUTE SAVORS SUCCESS

With the recent opening of its fourth formaldehyde plant in the last five years, at Castellanza, Italy, Montecatini now has facilities to produce 100,000 metric tons of 37% solution annually at this loction, employing the methanol oxidation process developed at the Polytechnic School, Milan. And four additional plants with a total capacity of 280 tons/day are being erected or planned outside of Italy.

Although similar to the processes used by Reichhold Chemicals, Inc., at its Seattle and Tacoma, Wash., plants (*Chem. Eng.*, Nov., '54, pp. 109-10, and March 9, '59, pp. 77-78), there are some notable differences between the two.

The Montecatini process:

- Employs mineral oil to transfer heat from converters to steam boiler. Reichhold uses Dowtherm.
- Uses reacted gas to heat incoming air and air-methanol mixture. Reichhold uses Dowtherm heated by the gases.
- Vaporizes methanol by mixing with previously heated air. Reichhold used steam.
- Costs less to build—estimated cost for 50-million-lb./yr. facility, $304,000. Reichhold's 25-million-lb./yr. Tacoma plant cost $250,000.

▶**Process Briefs**—In the Montecatini operation (flowsheet p. 46), unfiltered air is blown through a shell-and-tube heat exchanger, where it is heated by hot reactor gases, which then discharge to the absorption tower at slightly above 212 F.

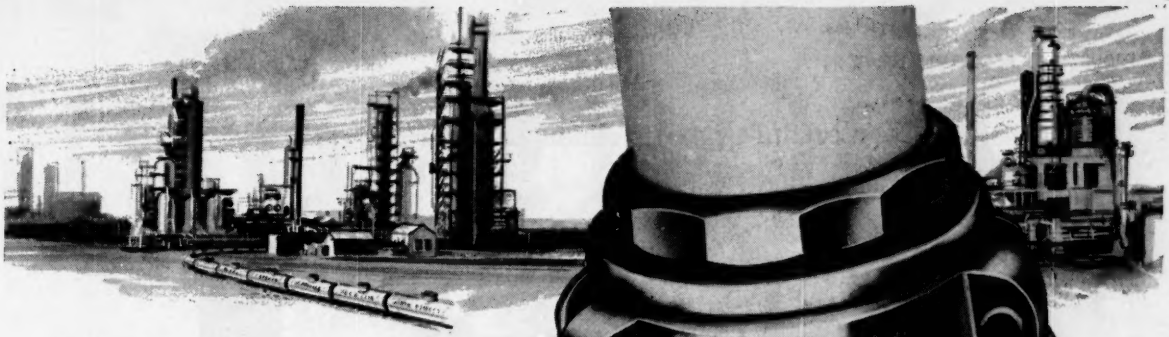
The heated air then enters an evaporator where it meets and vaporizes liquid methanol. Feed of methanol is carefully controlled to insure that the concentration does not exceed 8% of the air-methanol mixture.

The mixture leaves evaporator at about 105 F. and enters second shell-and-tube exchanger, which is also heated by reactor gases. Here, the mixture is heated to desired reactor-feed temperature before it enters the converters.

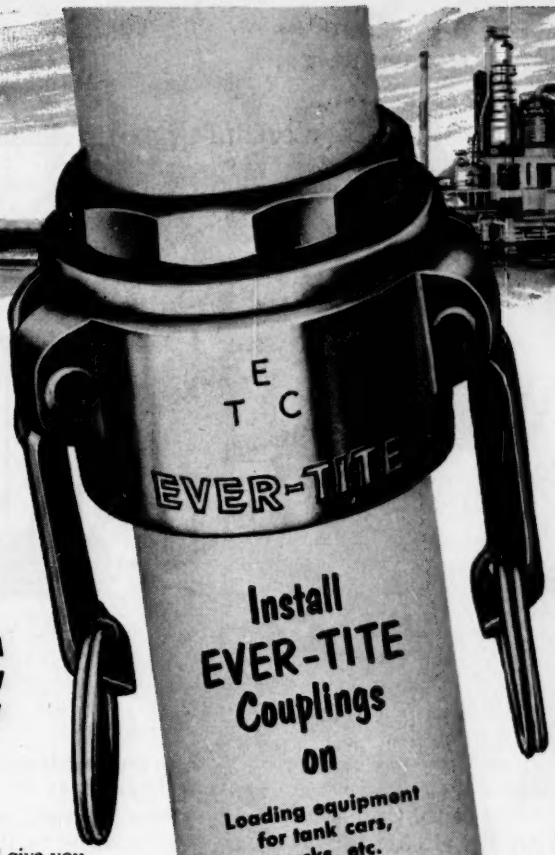
Employment of two heat exchangers, one before and one after the vaporizing step, is said to increase recovery of heat from reactor products, and require less exchange surface than a single unit.

▶**Downflow Reactor**—Converters are comprised of bundles of vertical pipes filled with catalyst. Excess heat is removed from the pipes by mineral oil, which is then pumped through a boiler to produce high-pressure steam — approximately 700-lb., 300-psi. steam/ton formaldehyde solution in addition to that used to heat the control room.

Oil enters at top of the specially designed converters and flows downward outside of the tubes, parallel to gas movement on the inside. This design, plus controlled circulation of the oil, permits use of inexpensive mineral oil without breakdown or cracking. Also, the temperature gradient of the oil entering and leaving the converter can be adjusted to achieve maximum yield of formaldehyde, resulting in a prac-



Make QUICK, TIGHT connections with EVER-TITE Couplings



In every operation that calls for couplings, Ever-Tite will give you tighter, safer, connections—speed up changes and reduce "down time"—save leakage, maintenance and money.

Ever-Tite Couplings give a tight connection every time—under all conditions, for all flowable materials—because tightness is pre-determined and built in by compression on a resilient gasket*. And Ever-Tites are quick to connect—by just slipping the coupler over the adapter and closing the handles.

When you install Ever-Tites you get leak-proof connections between stationary equipment and portable equipment . . . utmost flexibility . . . quick interchange of couplings for experimental set-ups.

Available in Brass, Malleable, Stainless, Aluminum, Monel, or other materials for corrosion resistance under any atmospheric or operational conditions. In sizes, high and low temperatures, and pressure ratings to meet *your* needs.

Write today for illustrated catalog No. C-11.

*Ever-Tite gaskets are regularly supplied of Buna N composition. Also available in Neoprene, Pure Gum, Butyl, Silicone, Teflon, Thiokil, or any other material to meet specifications.

EVER-TITE COUPLING CO. INC., 254 WEST 54th STREET, NEW YORK 19, N. Y.

Install EVER-TITE Couplings on

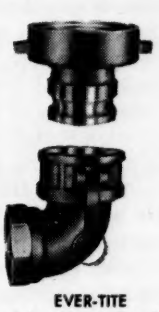
- Loading equipment for tank cars, trucks, etc.
- Steam, air and water lines
- Pumps and other machinery
- Blending equipment
- Container filling devices
- Fire hydrants
- Acid handling at storage and transfer locations

"If it calls for couplings it calls for EVER-TITE"

EVER-TITE Standard Adapter and Coupler

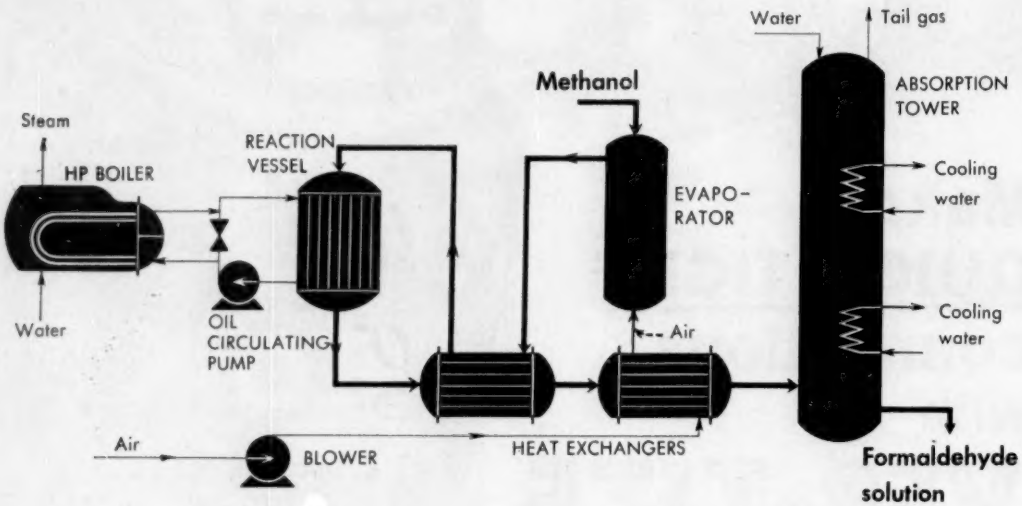
EVER-TITE Shank Hose Coupling

EVER-TITE Adapter and Coupler



EVER-TITE Adapter and Coupler for Tank Car Unloading

Montecatini's process eliminates intermediate steps



tically methanol-free final product.

Reactor gases from converters flow through the methane-air heater, the air heater and finally enter the absorption tower. This is a multistage unit in which the gases move counter to water. Formaldehyde is absorbed to produce a 37-44% solution, as desired. It is removed continuously from bottom of tower, while the tail gases are vented to the atmosphere.

Residual heat of reactor products, dissolution heat of formaldehyde, and condensation heat of water formed during the reaction are removed by water circulated through cooling coils in the tower.

▶ **Instrumentation**—The plant is highly automated, with such operations as methanol feed to vaporizer, water level and pressure in boiler, and feed of water to absorption tower, automatically controlled.

Composition of air-methanol mixture is determined continuously and maintained at 6.7-8% by volume (below lower explosion limit) by a regulating device that controls feed of both products to evaporator. Should this instrument fail, a pneumatic valve in the methanol line stops the flow and actuates warning signals.

Instrumentation for the four units at Castellanza is assembled in one control room. This arrangement makes it possible to operate the entire formaldehyde plant with two men/shift.

▶ **Metal Oxide Catalyst** — The Montecatini catalyst consists of oxides of polyvalent metals. Prepared by a special process at the company's research institute in Novara, it possesses exceptionally high mechanical resistance that practically eliminates dust formation. This reduces pressure drop in the converters so that power requirements for gas recycling are minimized.

Selectivity of the catalyst results in high-purity formaldehyde containing minute amounts of methanol and only traces of formic acid. Its long useful life (more than 18 mo.) results in specific production of more than 9 tons of 37% formaldehyde solution for each lb. of catalyst used.

Formaldehyde yield remains constant within a wide range of space velocities, provided temperature of catalyst and methanol concentration are kept constant. When working at a reduced space velocity, methanol reacts completely but CO and CO_2 are formed as byproducts.

If space velocity is increased, the amount of byproducts decreases, but sizable amounts of methanol remain unreacted. In the plant operation, methanol content is usually kept between zero and 1% by weight.

Formic acid content ranges between 0.005 and 0.01%, lower than in conventional commercial products.

▶ **Materials of Construction**—Pipes used in the converters and heat exchangers are of AISI-304 stainless steel (18% Cr, 8% Ni). This material is credited with attainment of the low formic acid content.

To minimize impurities and colors in the formaldehyde solutions, the absorption tower should be either AISI-304 stainless or aluminum. Montecatini uses 99.7%-pure aluminum.

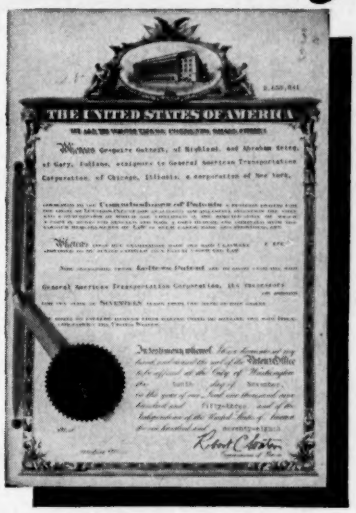
Storage tanks are of mild steel, suitably coated or painted. Remainder of plant can also be of steel.—AVG

Requirements for one ton of 37% formaldehyde solution

Methanol (99 pure)	0.435 tons
Catalyst	0.11 lb.
Mineral oil	0.66 lb.
Electric power	70.00 kwh.
Water (60 F.)	5,826 gal.

a Reminder

to those who use chemical nickel alloy plating:



There is only ONE

Kanigen®

and 29 patents prove it

There are no substitutes for Kanigen—no other process that applies a hard, corrosion-resistant nickel alloy coating without the use of electricity as Kanigen does.

With Kanigen, you can plate anything from a small relief valve to a 20,000 gallon tank car with a virtually non-porous, uniform coating.

How can you be sure of getting Kanigen? Only one way—by calling General American or one of its licensees. For further information write:

GENERAL AMERICAN TRANSPORTATION CORPORATION

Kanigen Division
135 South LaSalle Street
Chicago 3, Illinois
Offices in principal cities

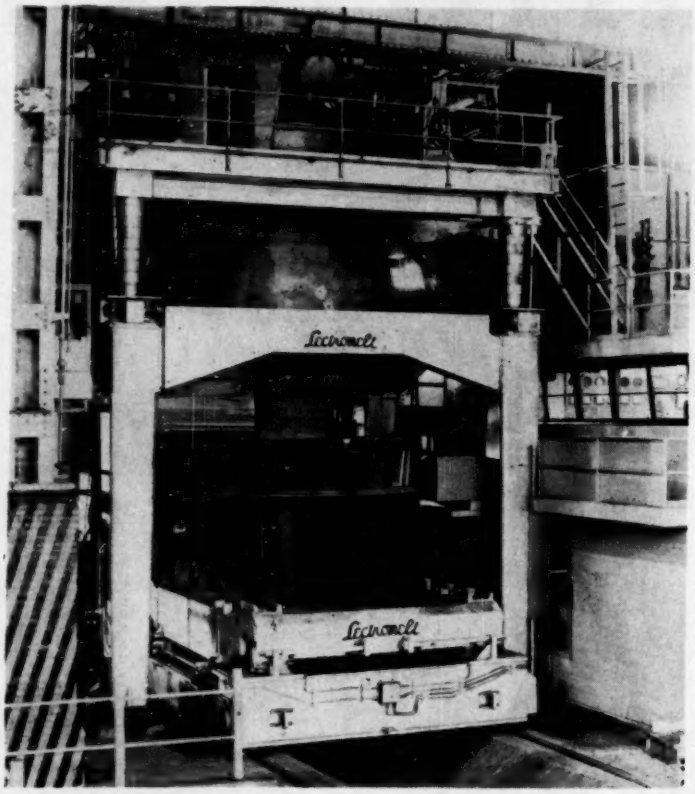
LICENSEES

INDUSTRIAL KANIGEN CORPORATION
1421 Park Avenue
Emeryville, California

KEYSTONE CHROMIUM CORPORATION
1095 Niagara Street
Buffalo, New York

KEYSTONE METAL FINISHERS, INC.
22 Raydol Avenue
Secaucus, New Jersey

Degassing unit operates like giant coffee maker



Crucible Steel Co. has completed preliminary tests of a new vacuum degassing unit at its Pittsburgh, Pa., steel mill (Chementator, Dec. 26, 1959, p. 22). Results to date in degassing melts of highly alloyed steels are described as "generally encouraging." Unit, licensed from Germany's Dortmund-Horder, is the only device of its kind in North America. In operation, it resembles a huge Silex coffee maker: a long-necked vacuum chamber is dipped below slag level in the molten metal ladel (shown in photo above). When a vacuum is applied, molten steel flows upward into the chamber and is degassed. Unit was built by Lectromelt Div. of McGraw-Edison Co.

Russia Gains In Mineral Strength

Russia's mineral exports in 1959 gained 14% in value over 1958 and were twice the 1955 value, indicating that she is producing more than she needs of many commodities. In contrast, the value of mineral imports last year was less than 7% above the 1958 figure and 40% higher than the total mineral import value five years ago.

These figures are contained in a Bureau of Mines statistical report just released by the Department of the Interior.

The Soviets cut down on shipments of zinc, tin and aluminum to Free-World countries in 1959, while delivering substantially more of many bulk products, including solid and liquid fuels, iron ore, pig iron, rolled steel, manganese ore, chromite, asbestos, apatite concentrate, and potash salts.

Minerals and fuels accounted for more than a third of the value of all Soviet exports in 1959, with liquid fuels and coal showing the biggest gains over the previous year. Although fuel imports also increased. Russia remained a large net exporter of both coal and petroleum.

Navy Brightens Aluminum Picture

New fleet construction, under way or authorized in the 1961 budget, promises to consume 40 million lb. of aluminum as follows:

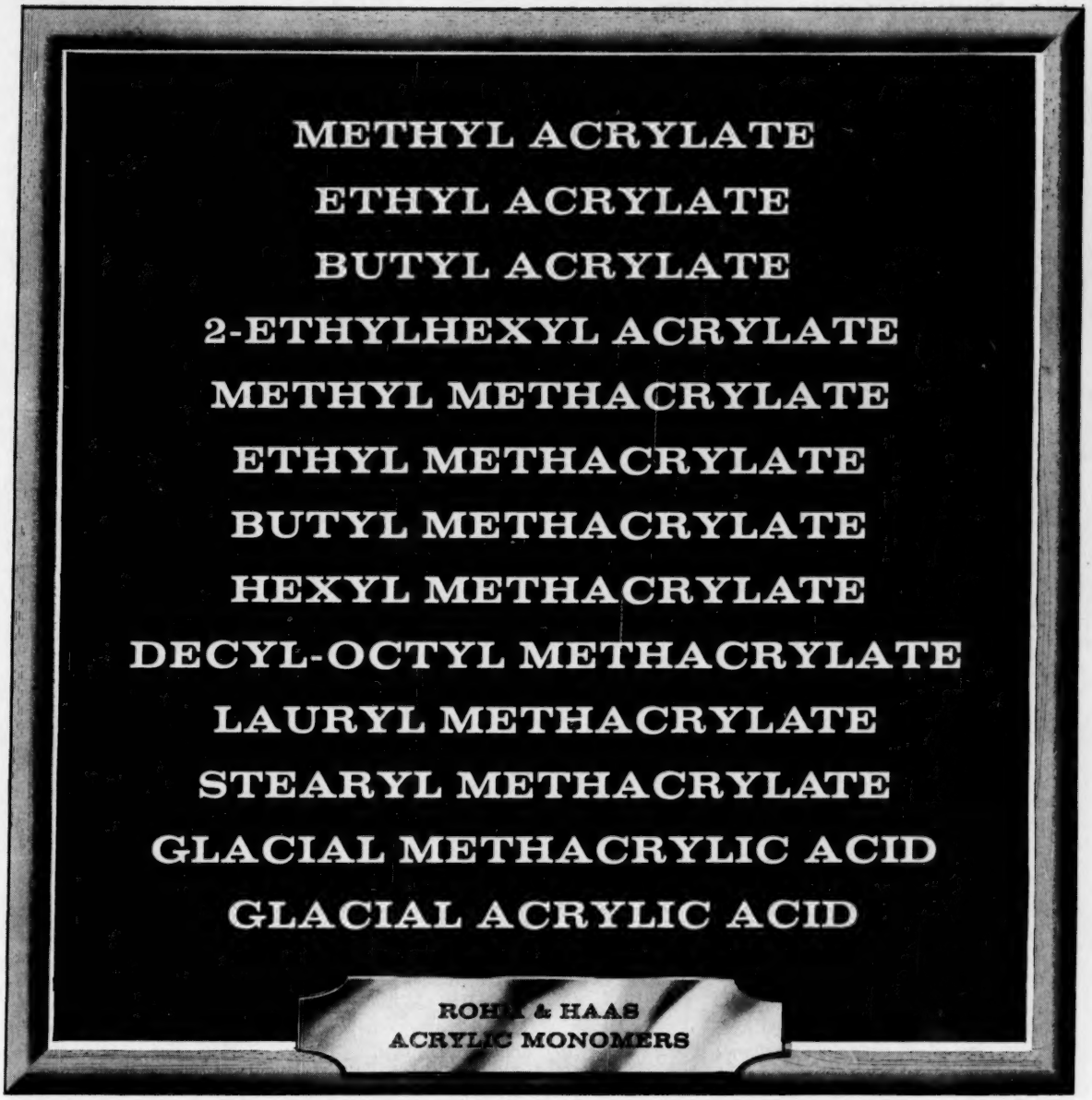
Attack aircraft carriers...	9,063,000
Guided-missile cruiser....	145,000
Guided-missile destroyers.	9,706,000
Guided-missile frigates...	18,239,000
Escort vessels.....	252,000
Amphibious transport docks.....	1,600,000
Amphibious assault ships.	577,000
Minesweepers, ocean (nonmagnetic).....	75,000

Aluminum recently made news in other forms of transportation, too, with the completion of 1,250 aluminum hopper and gondola cars for the Southern Railway System and the introduction of New York subway cars using over a ton of aluminum per car.

For shipment of bulk products by waterways, plans were announced for the construction of double-hulled aluminum barges 130 ft. long, with 12,500-bbl. capacities.

And in the latter part of '60, it appeared likely that most of the frozen citrus juice pack would reach consumers in all-aluminum or partially aluminum cans. As it is, the canning and packing industry consumed about 25,000 tons of aluminum in '60, about three times the '59 volume.

Such items of good news are doubly welcome since the industry's 2,468,750 tons of primary aluminum capacity is currently about 22% unused. According to the Aluminum Assn., aluminum output in the U. S. in '60 bettered '59 production by 3%; estimates of total production for '61 were set at just over 2 million tons.



This roster identifies your best source for acrylic monomers

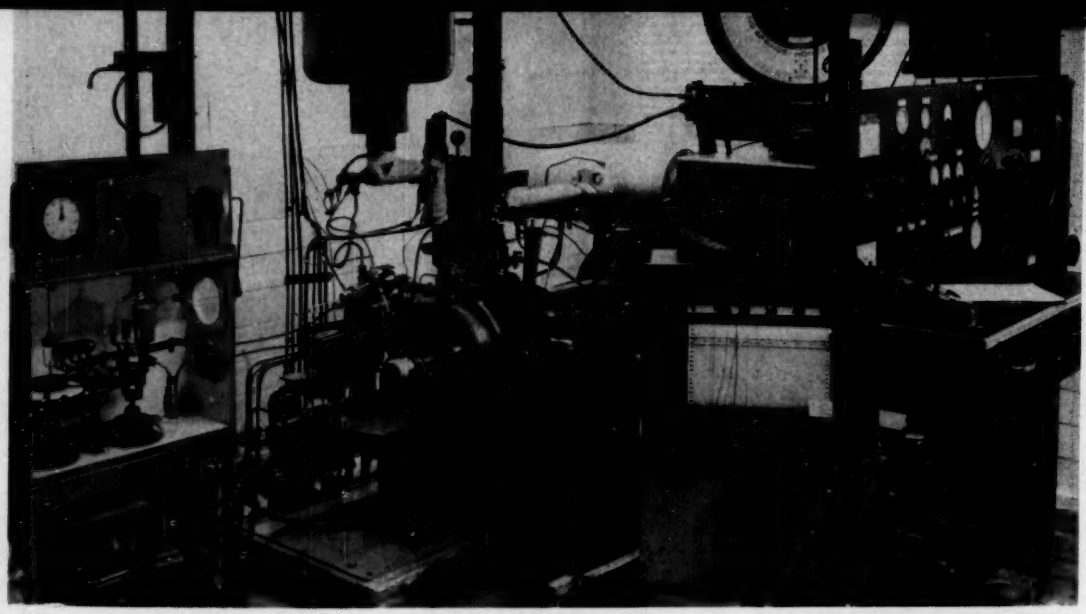
Wide selection and efficient service make Rohm & Haas your best source for convenient, low cost purchasing of acrylic monomers.

You can reduce costs through planned buying of mixed shipments of acrylic monomers and emulsion polymerization auxiliaries such as TRITON emulsifiers and LYKOPON, FORMOPON, and sodium thiosulfate reducing agents for redox catalyst systems.

Write to Dept. SP-6 for technical literature and samples.

ROHM & HAAS
PHILADELPHIA 5, PA.

TRITON, LYKOPON *and* FORMOPON *are trademarks, Reg. U.S. Pat. Off. and in principal foreign countries.*



Tests were carried out on single-cylinder engine (center) equipped with fuel and air induction systems shown.

NEW FUEL TEST MAY CUT BLENDING COST

Technique that compensates for automatic devices on present-day motors is proposed as replacement for 30-yr.-old octane rating methods now costing refiners an estimated $10-million/yr. in overblending.

Wanted: a simple, precise method for determining octane ratings of motor fuels.

That, in short, is the cry from refiners who are today finding their 30-yr.-old standard motor and research methods outdated and terribly expensive. Since most refiners now overblend rather than take chances on falling below specifications, it is estimated that the lack of an accurate octane determination is costing the industry as much as $10-million/yr.

The search for new techniques began shortly after World War II. But when the octane rating scale was extended to over 100, several years ago, the search really became intensive.

Since each increment above 90 has more effect on performance than a corresponding increase in the 70-90 range the higher above 90 the octane went, the less precise were the motor and research methods for determining octane numbers for blending purposes.

▶**Old Tests Unrealistic** — The motor and research methods stress fuels into the knocking zone by increasing compression ratio. Spark advance is not adjusted to best performance. Knock intensity, used as the criterion, is at least one compression ratio above "incipient" knock.

Mechanical shortcomings contribute further to loss in precision. Among these are: poor carburetion, poor valve timing, spark advance "drift," differences in knock-meter pickup characteristics, questionable combustion chamber design, the very "wet" cast iron piston, and undesirable spark plug location.

Recent studies have been aimed at developing methods that are inherently precise, that correlate with road performance and have the ability to unerringly describe fuel quality.

▶**Several Methods Proposed**—The studies have resulted in development of a number of methods, each by a different refiner. However, none has been accepted by the petroleum industry as a whole.

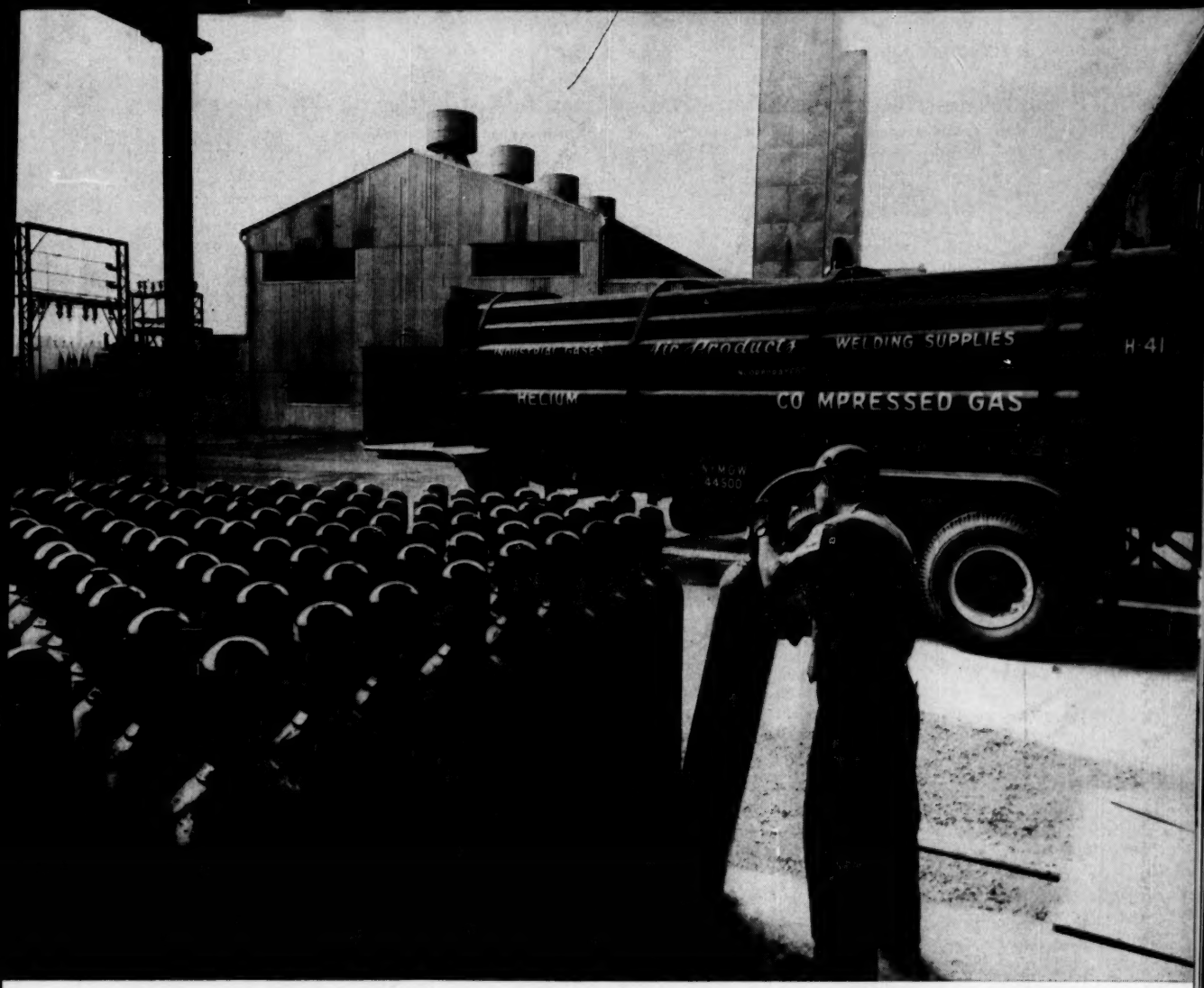
One technique, the subject of several papers presented at ASTM meetings during the past several months by Bruno R. Siegel of Sinclair Research Laboratories, recognizes that manifold air pressure is the motorists's only operating variable and it, therefore, rates fuels accordingly.

Called the Severity Knock Testing Method, the new technique comprises determining the knock-limited manifold air pressure of fuels at various compression ratios. Fuel quality is then described by a knock-limited air manifold pressure curve over a large compression ratio range (see Fig. 1).

Data may be extrapolated by using reciprocal values of these parameters to describe quality from zero manifold pressure at infinite compression ratio to infinite supercharging at 1:1 compression ratio.

Various reference fuel systems or various blends of base stocks produce melon-shaped graphical patterns. These frameworks may be superimposed on each other to aid blending and performance predictions. Additives create bulges on the curves of base stocks (Fig. 2).

Ratings may continue to be expressed as octane numbers, but they



Air Products Inc., one of America's leading manufacturers of industrial gases and producers of cutting and welding equipment, uses Taylor-Wharton Gas Transports as part of their industrial gas distribution system.

And no wonder.

Low initial cost, extreme mobility and economical storage make Taylor-Wharton Gas Transports ideal for the bulk transportation of compressed gases as well as for semi-permanent storage.

Many other of the nation's gas producing, oil refining, petrochemical, food and electronic companies now employ flexible, mobile gas transports.

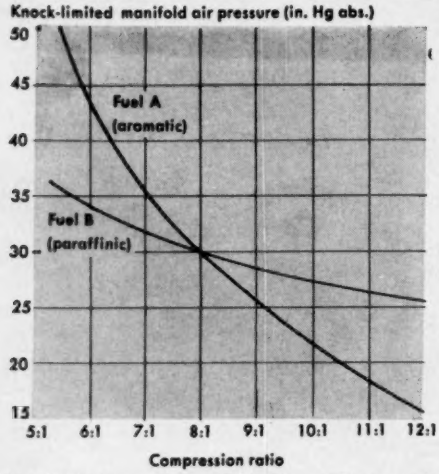
Why don't you? Write to:

More than a Century in Harrisburg 26, Pa.

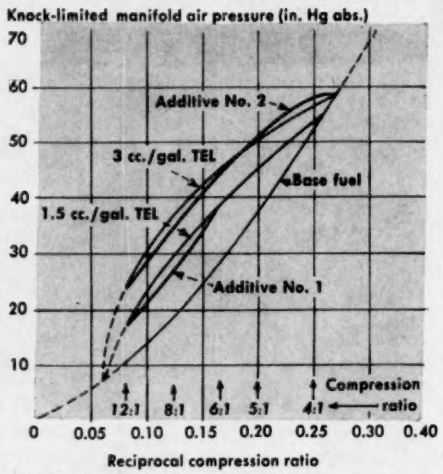
HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

Curves describe fuel behavior at various manifold pressures, compression ratios



Manifold air pressures at knock point for various compression ratios give curves that describe quality of various types of fuels.—(Fig. 1)



Additives produce bulges on curves of base fuels that indicate their pro- and antiknock effects at different compression ratios.—(Fig. 2)

are associated with the compression ratio at which they were obtained rather than with a method name such as ASTM "motor," "research," "aviation," or "supercharge."

When rating by this method, ignition timing is maintained at peak power, manifold air pressure is increased to induce knock, while all other conditions are constant.

▶ **Reference Fuels are Key**—The new approach relies on reference fuel equivalencies to relate full-scale requirements and laboratory ratings. Vehicular requirements are established by at least two diverse types of reference fuel systems and one or more commercial-type fuels. Types used include: paraffinic—blends of isooctane and n-heptane; aromatic—blends of toluene and n-heptane; olefinic—blends of diisobutylene and n-heptane. The commercial fuels may be blends of superpremium, premium and regular grade.

In applying this concept, requirement of a vehicle is established in terms of specific blends of such reference fuels. The quality *vs.* severity frameworks of these fuels, as established by the laboratory engine, are superimposed on each other. Requirement is then spotted at intersection points of the blends that the car established as having equal antiknock quality at a given operating condition.

A vehicle, operated at a predetermined speed and throttle setting can then be represented by a point on a chart, by plotting severity against octane number. If three reference fuel systems are used, the vehicle is represented by three points, which may be connected to form a triangle. If four systems are used, the vehicle is represented by hexagon. Sizes of these figures establish degree of correlation that has been achieved.

▶ **Modified Motor Used**—All of the exploratory work has been done on modified supercharge-method test units. The CFR-48 crankcase and variable speed dynamometer have proved adequate for investigating fuel behavior over a large operating range.

Cylinder assembly specified for the aviation method has been used. This provides a relatively dry, aluminum piston and eliminates the turbulence and throttling created by the 180 deg. shroud on inlet valve of research and motor method test units.

Data obtained on an audible knock basis have been within two octane numbers of the corresponding road determinations. It also has been established that the severity range of a high percentage of cars can be encompassed by operating the laboratory engine between 5:1 and 8:1 compression ratio. If it is considered desirable to have mild and severe methods for specifications, ratings at these two ratios might be satisfactory. If a single method is preferred, however, ratings obtained at 6:1 or 7:1 will cut through the center of the car population and a specific method could be developed in this area.

It has also been noted that the Waukesha GPI-1 meter—which is designed to measure intermittent, light knock—agrees very well with audible observations. This means that very precise, significant numbers can be delivered by changing engine operating conditions in an orderly manner, and by using available equipment that already has been approved for one or more of present ASTM methods.—THA, AVG

Sinclair test is keyed to good engine performance

Constant conditions

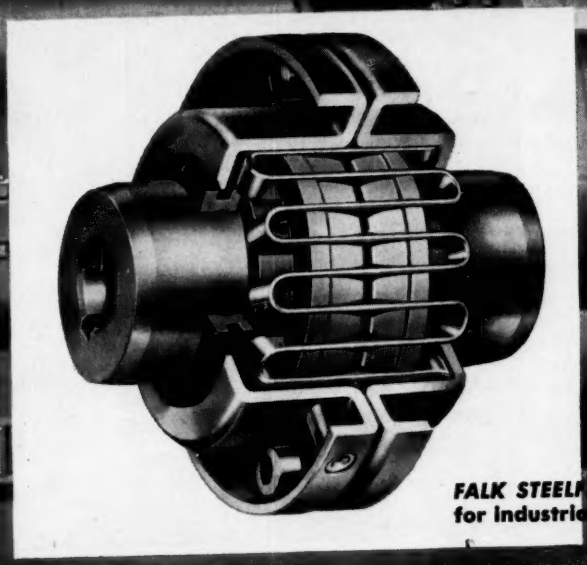
Engine speed	1,800 rpm.
Fuel-air ratio	0.078 (12.8 A/F)
Spark advance	Peak power
Compression ratio	Held constant at several levels
Mixture temperature	100 F.
Jacket temperature	212 F.
Exhaust pressure	2 in. water

Variable condition

Manifold pressure	Increased to induce knock

FALK

A GOOD NAME IN INDUSTRY



FALK STEELFLEX COUPLINGS
for Industrial

Close Falk Coupling smooths out steel blooming mill perfo

On a blooming mill at the Copperweld Steel Co
Warren, Ohio, installation of a large Falk Steelflex
tween motor and pinion stand eliminated troublesome
vibration which threatened to damage mill machinery. Transmitting
5,000 hp. at 50/100 rpm, this is not the largest Falk coupling in
others are designed to transmit up to 130,000 hp. at 100 rpm.

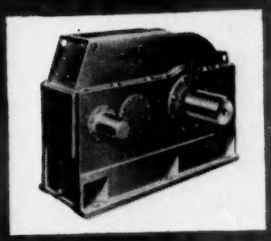
This installation and others like it prove the Falk concept of shaft
coupling design—namely, a modern shaft coupling must contribute
to the successful performance of the machinery it
What does this mean to you? As in
as standard Falk grid-groove design does
ance, and the difference is torsional resiliency
steel ... reason enough to specify Falk Steelflex
life" insurance for your connected machinery.

Falk
sizes
160

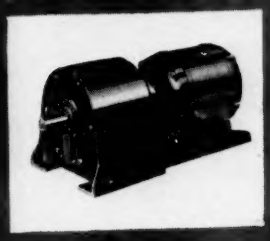
THE FALK CORPORATION, MILWAUKEE
MANUFACTURERS OF QUALITY GEARS, SPEED REDUCERS AND FLEXIBLE

A Rating ... Whatever power drive or
"Falk" ... Write for Falk publication

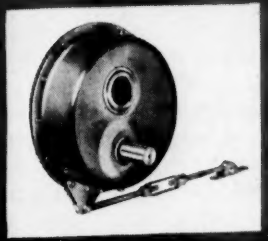
America's First Family
Transmission Products



SPEED REDUCERS. Parallel Shaft up to 3500 hp. Ask for Bulletin 1100. Also Right Angle and Concentric Shaft designs.



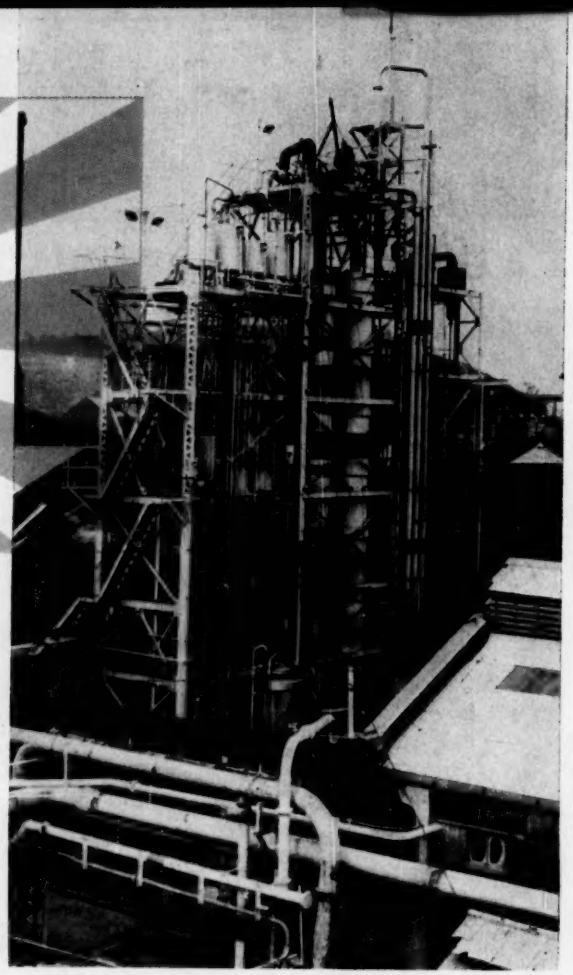
ALL-STEEL MOTOREDUCERS —up to 75 hp. Horizontal, Vertical, and Right Angle. All-Motor and Integral Types. Ask for Bulletin 3100.



SHAFT MOUNTED DRIVES —up to 100 hp. Ask for Bulletin 7100. Also Plunger Mounted and Screw Conveyor Drives.

FALK, STEELFLEX and ALL-MOTOR are registered trademarks

JAPANESE CHEMICALS BOOM



Acetic acid plant at Shin Nippon Chisso Hiryo in Minamata.

Using imported technology and raw materials, Japan's booming chemical industry makes products that compete in world markets with increasing success.

DONALD F. OTHMER
Polytechnic Institute of Brooklyn

Shy on raw materials and technological know-how, the Japanese chemical industry strides briskly into 1961, supplying greatly increased needs of a rising economy, and more than holding its own in world markets.

Secondary beneficiary of this paradoxical situation is the U.S. chemical industry. In '59, Japanese chemical imports increased 33% compared with '58, amounting to $211 million. The U.S. chemical industry supplied the majority of these chemicals, and its share increased 74% in '59 compared with the previous year, to raise American invoices to a total of $121 million. In number of processes and royalties, too, Japan's chemical industry is still paying heavy dollar tribute to its counterpart in the U.S.

▶**Rising Economy**—Gross National Product (GNP) is increasing 11%/yr. compared with 6% in the U.S. and 4% in Europe. Exports have increased 72% since '56, to the point where Japan will soon reach a favorable trade balance for the first time in many years.

Workers already have the highest standard of living in Asia and it is increasing—admittedly, from a low base—faster than in any other major country. There is one new house for every three families, 30 times as many TV sets as in '55, 10 times as many motor vehicles as 10 years ago, 20 times as many telephones as prewar.

Consumption of chemical products in general increased 70% between '55 and mid-'59. The index of production of chemicals was more than seven times as much in '59 compared with '48. Exports of general chemicals amounted to $167 million in '59, a 21% increase compared with the previous year.

Only prices declined. Vinyl chloride tabs, for example, fell 55% between '52 and '58 (to the benefit of U.S. importers). Polyethylene price came down 23% between '56 and '58.

▶**Fundamental Weaknesses**—But the real wonder of Japan's chemical industry today is that it has boomed in the face of severe weaknesses in its very foundation. In the words of R. Sano, president of Tekkosha Co., a vigorously expanding ferroalloy and acetylene chemicals producer: "We are flooded with small companies; we import much of our raw material; our energy sources are high priced; in some cases, our techniques are inferior to those elsewhere in the world."

Traditionally understood to be Japan's heavy counterbalance to these defects, low labor costs are no longer the factor they once were: industrial labor now costs over 50% more than in '52.

▶**And Strengths**—On closer study of the various aspects of the Japanese chemical industry, its real strengths repeatedly reveal themselves as the people's intelligent appreciation of new developments in other countries and their ingenuity and ability in utilizing raw materials. With overpopulation, individuals compete vigorously, work harder for longer hours, live on less. National economy benefits.

We torture our rigid PVC pipe more than you ever will

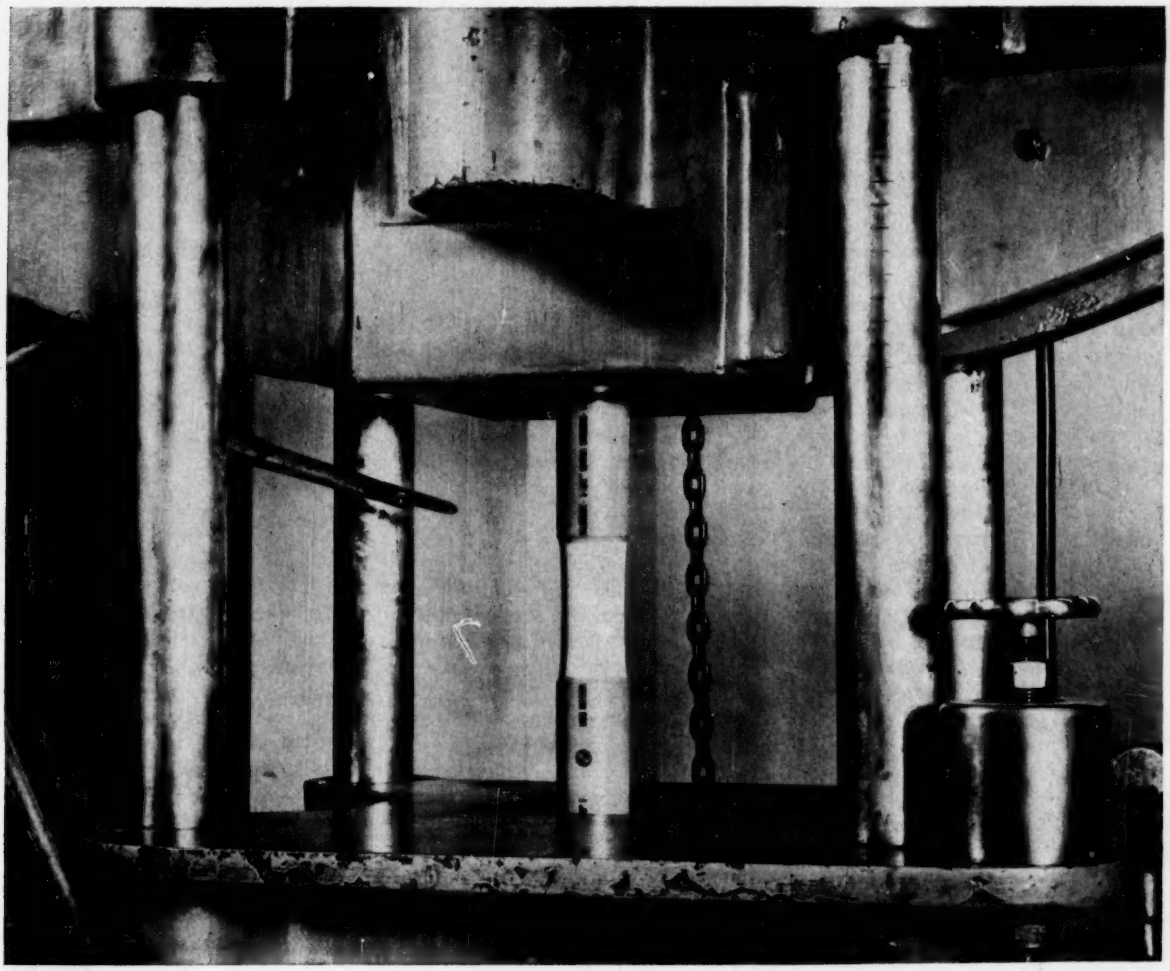
In this test, we pull it apart to check its tensile strength. We also give PVC Pipe "Creep Tests," "Burst Tests," "Collapse Tests," "Stress Cracking Tests" and, for good measure, we soak it in corrosive chemicals. That's why we know USS National Polyvinyl Chloride Pipe will stand up in service.

There's no chemical corrosion with USS National PVC Pipe, no build up of internal deposits. It handles most acids, alkalies, salt solutions and alcohols as safely, as efficiently as it carries water. It cleans easily, installs quickly. Tight permanent joints are simple to make with either solvent cement, heat welding or adhesives. Or, if you like, you can thread Schedules 80 and 120 PVC Pipe.

USS National PVC Pipe comes in sizes from ½ inch to 12 inches diameter and Schedules A, 40, 80 and 120. There are two types: *Normal Impact*—combines highest chemical resistance with high strength and excellent creep resistance; *High Impact*—excellent chemical resistance and a high degree of toughness, even at low temperatures.

Get the complete story of why USS National PVC Pipe has found so many uses in the chemical industry. Write for Bulletin No. 24. National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and National are registered trademarks

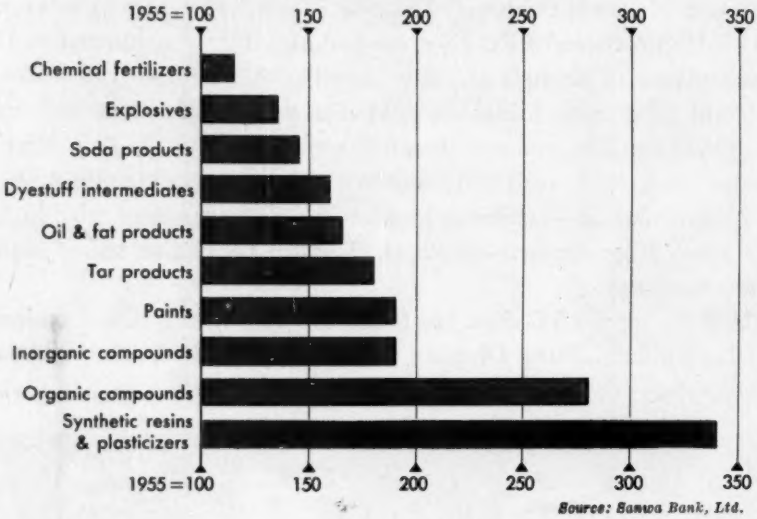


NSF

USS **National Tube Division of United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Export Company, New York

Plastics paced growth in consumption of Japanene chemicals to mid-'59



Source: Sanwa Bank, Ltd.

The Japanese are exporting finished products based on imported raw materials, which compete on the world market with those of countries completely integrated as to raw materials.

Increasing exports of steel from Japan to the U. S. reveals that American steel is being priced not only out of world markets, due to spiraling U. S. labor costs, but also out of some domestic markets. Yet, to export steel, Japan must import part of its iron ore and coke.

Some U. S. resentment has been noted over Japanese exports of rayon, although this represents only a small percent of the total rayon used here. Never noted simultaneously is the fact that by far the largest amount of wood pulp used in all rayon production in Japan is imported from the U. S.

► **Raw Materials, Short**—Japan imports about 150,000 metric tons/yr. of salt from America, valued at about $1.5 million. This is about 10% of that nation's salt imports and represents about $10/ton as the cost for salt. Ten years ago, the price was twice as high; expensive indeed was brine going to a caustic-chlorine cell compared with its American counterpart. (The comparatively high price of a Japanese Btu. dictates the use of mercury cells to give concentrated caustic effluent not requiring heat for evaporation.)

In '59, Japan exported to the U. S. $1,030 million of all commodities and imported $1,112 million. In every year, exports to America have been less than imports from America, although the formerly very large difference is being reduced.

► **Technology, Growing**—The Japanese attitude toward research is entirely different from that in America (where companies expect to do their own development work) and only rarely is a new process purchased from outside. The feeling is that, since the country's industrial development is very far behind that of America and Europe and since America alone can afford to spend over $15 million/day for research, Japan can never catch up. Industry has resigned itself to purchase from abroad its know-how in the fully developed stage. The competitive position between companies is such that as soon as one company wants to purchase know-how, others frantically join in the bidding, and everyone tries desperately to buy not only processes but time.

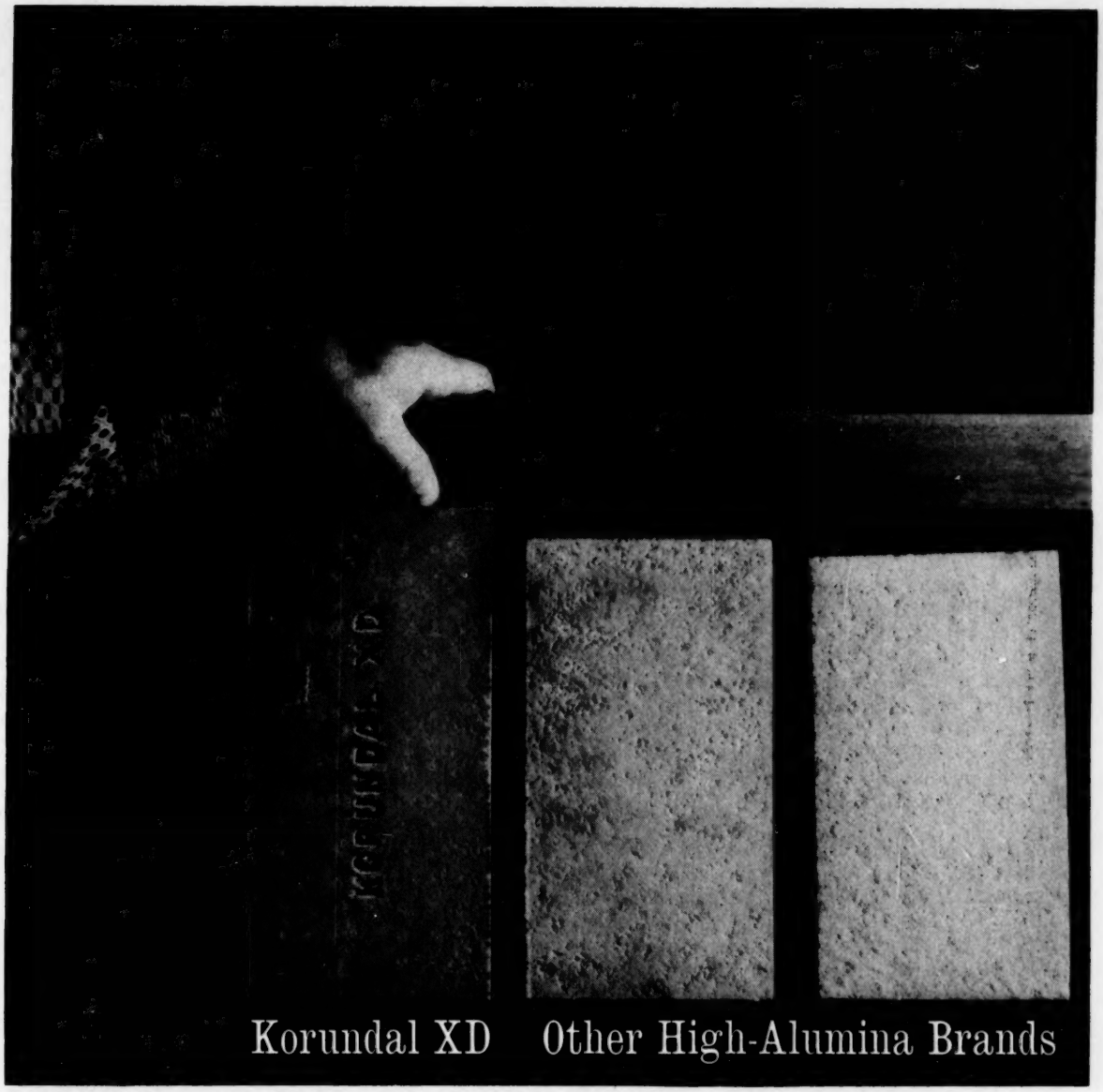
American engineering companies, in making the installations, are finding that detailed engineering is done far more cheaply in Japan, due to much lower salaries and overhead. Only process data may be sent over, therefore, for incorporation in designs rolling off Japanese drafting boards.

Some developments and manufacture of new products have been initiated in Japan, however. It has developed an acrylic fiber process, Asahi's Cashmilon, dating from wartime research. At least one company has developed its own urea processes. Another has introduced the use of titanium chloride in special purification processes for sewage and other water treatment, radioactive waste disposal, etc.

An extensive research program by a research group and two of the major chemical companies has indicated that even at the relatively high cost of wood in Japan, crystalline glucose and various byproducts can be made profitably from that source. A plant costing about $6 million will make 5,000 tons/yr. of glucose, 2,000 tons of furfural and 450 tons of methanol, together with various mechanical or building products. Such processes in Germany, Sweden and the U. S. have not been successful, but new Japanese techniques and more sophisticated byproducts indicate profit for the present venture.

Toyo Soda is the first company in the world to install a plant for the production of wet process phosphoric acid utilizing hydrochloric acid (the IMI process developed in Israel, *Chem. Eng.*, Apr. 18, 1960, p. 81). Research scientists in Osaka have also developed a greatly improved catalyst for the gas-phase production of acrylonitrile from acetylene and HCN.

There will not be enough acetylene for years in Japan; now made from carbide it is about 10-12¢/lb., with hopes that by '64 some improvements in production may give a low, at favored installations, of 7.5¢/lb. Several Japanese companies are pilot planting, this year, a new acetylene process for the thermal cracking of methane that gives almost 100% conversion and practically no byproducts other than theoretical acetylene and hydrogen. Two other acetylene processes have been developed and are well into the pilot-plant stage.



KORUNDAL XD shows no subsidence in extended 3000°F. Load Test

Test shows amazing Hot Load Capacity of new Harbison-Walker Refractory

The hot load test results on KORUNDAL XD compared with similar high-alumina brands are most revealing. Whereas, KORUNDAL XD showed no subsidence in a special, severe load test at 3000°F., the other brands in the same test deformed 5.1% and 9.6% (see above photo).

KORUNDAL XD is very dense, strong, and has good resistance to thermal shock. This unprecedented combination of high hot strength and improved physical properties will suggest solutions for many of your furnace problems. Our engineers will be glad to give you complete technical information.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
WORLD'S MOST COMPLETE REFRACTORIES SERVICE
General Offices: Pittsburgh 22, Penna.
HW 61-3

Another Japanese company will be pilot planting a new electrolytic cell giving high-purity manganese via a continuous process for maintaining very pure cell liquors; also a non-electrolytic process for a mixture of nearly pure manganese oxides from complex ores.

Still another expanding company is pilot planting a new zinc thermal refining process credited with giving almost 100% of the zinc, even in recalcitrant ores, as high-purity metal.

Not only is much use of transistors made in final products in Japan, but much of the background of pure metal research was developed there. (The electronic industry also piled up a startling one-transistor-per-person market in '60.) As might be expected from the traditional Japanese skills in miniatures, or microminiatures, the tunnel diode that takes only 0.1% as much power as a transistor was developed by Esaki, a Japanese.

It should be noted that Vinylon and insoluble polyvinyl alcohol fiber were invented at Kyoto University. Here's a case of reverse "lend-lease," where Japanese know-how has been successfully transplanted to the U. S.

Japan has always been the largest consumer of monosodium glutamate. MSG was invented at the University of Tokyo and has been manufactured on a tonnage scale for over 50 yr. The fermentation process for MSG was developed in Japan and exported to America. Now, the Ajinomoto Co., world's largest MSG producer, is to make it from acrylonitrile, certainly a dramatic step in the direction of the oft-promised "food from petroleum."

There are at least two important Japanese variations of the ammonia-soda process. One uses liquid ammonia as a solvent for salt and carbon dioxide to give a much higher utilization of salt than in the usual process. Salt, as noted previously, is very expensive in Japan—no natural resources and too much rainfall for the solar-produced variety. The second modification of the ammonia-soda process is an improvement of the Schreib process, which takes out ammonium chloride as pure anhydrous crystals, uniform in size and dust-free. Fresh ammonia is fed to the system. (A market has been developed for ammonium chloride for fertilizers.)

▶ **Consumption, Up**—In '60, capital expenditures for plant and equipment in the petroleum industry were about 10 times those of '50, while in five years orders for chemical machinery and equipment have gone up over five times. Fiscal '60 promises a petrochemical investment of some $250 million from some 20 companies. And by '63, total investment will reach $840 million (*Chem Eng.*, Dec. 26, 1960, p. 40). The rate of increase of continuing yearly investment is 135%.

A tremendous help to Japan's prosperity has been bountiful rice harvests during the past five years. Much credit is due to what is probably the world's most extensive use of chemicals as fertilizers, insecticides and other aids.

▶ **Production, Up**—With the rapid expansion of Japanese industry, financial pages reflect that companies are periodically increasing their capitalization by sale of stock. Still another item unusual to American eyes is the frequent listing of collaborations with overseas companies for obtaining know-how, particularly American, on either a joint-venture or royalty basis.

Items of interest in these expansions are almost identical to those in this country. In five years, total synthetic textile production has increased about three times while rayon production has been about constant. The development of polypropylene fibers is as vigorously discussed in Japan as here, with an even greater sense of the constraint caused by the earlier European patent claims.

Japanese patent procedures are somewhat different; the publication of the application so that competitors may take exception to its granting gives somewhat greater advantage to the larger companies. The peace treaty allowed American patent applications of the prior dozen years to be filed, and thus lengthened their monopoly and time of intake of royalty tribute. (This was a delayed "war debt" payment, not completely settled in nylon's case nor those of some other important materials and processes for another half dozen years.)

▶ **Prices, Down**—A major source of Japanese chemicals for 50 years has been acetylene from carbide, basic cost of which has been electric power. Production in '60 of 1.25 million tons of carbide must be increased by at least 150,000 tons for '61 and is programmed for a total of 1.5 million tons by '64. But electric power available will soon limit this expansion. Many of the important organic enterprises have developed in Japan in the same way as did Shawinigan in Canada, from cheap electric power and calcium carbide, to give acetylene and its derivatives.

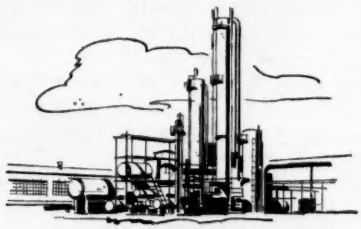
In Japan, the price of vinyl chloride resin, one principal product of acetylene, was lowered 55% between '52 and '58. One Japanese company, Sekisui, makes 1,000 tons/mo. of rigid vinyl chloride pipe. Always short of metals, Japan has found in plastics a long-looked-for substitute; the PVC pipe is used far in excess of its American quota in chemical plants—and in homes, from which it is barred here by obsolete codes.

Cost of raw material for vinyl chloride in Japan has been estimated as 22% higher than in the U. S., while the relative prices of the finished product are reversed: only about two thirds as much in Japan as in the U. S. In a 1,000-ton/mo. resin plant, the relatively smaller Japanese unit labor cost is not enough to account for this difference in a production item using so little labor.

▶ **Minus Benefits of Scale**—For polyethylene, the price decreased about 23% between '56 and '58. Plant investment costs for production of polyethylene have been estimated to be four times as great in Japan as in the U. S. Here, ethylene is obtained from natural gas or refining gas with relatively simple facilities; in Japan, a cracking plant from naphtha is necessary, requiring a much larger investment. Also, the Japanese plants are only a tenth as large as in the U. S., with a correspondingly higher unit investment cost.

"COOLING WITH PURECO CO_2 LIQUID...

eliminated a major bottleneck"*



*This statement was contained in an engineer's report concerning the use of CO_2 as a coolant by a company that sulfunates straight chain alcohol. CO_2 sparged directly into the chemicals in the reaction tank, maintains a controlled temperature of -70° F or below. Total time for cooling *55 minutes . . . former time 3 to 4 hours.*

Perhaps Pureco CO_2 Technical Service can save your company time and money, too!

New applications for Pureco CO_2 are being found constantly . . . new ways of doing things more efficiently and economically with this versatile chemical. The engineers in Pureco's Technical Service are highly trained in the application of its many uses . . . they are ready, willing and able to discuss, demonstrate or assist in the experimental development of CO_2 applications, whether they entail a new use for the product or the improvement of an existing one.

For example:

USE PURECO CO_2 AND/OR "DRY-ICE" AS A REFRIGERANT FOR . . .

Chill grinding of heat sensitive materials.
Chill grinding of animals' glands for hormones, etc.
Freeze-drying.
Blast chilling of environmental test chambers.

USE PURECO CO_2 AS A GAS FOR . . .

Inert blanketing of dyes, inks and other flammable mixtures.
Sparging of varnishes and other mixtures.
Distillation vehicle in distillation of phthalic anhydride in manufacture of resins.
Flushing out lacquer from TV tube interiors after optical coating.
Inert pressure medium.

USE PURECO CO_2 AS AN INGREDIENT FOR . . .

Forming carbonates, especially barium carbonates.
Manufacture of aspirin.
Controlling acidity—as in coagulating foam rubber.

Pureco is at your service. Call or write:

PURECO CO_2

PURE CARBONIC

Pure Carbonic Company, A Division of Air Reduction Company, Incorporated
Nation-Wide Pureco CO_2 Service-Distributing Stations in Principal Cities
General Offices: 150 East 42nd Street, New York 17, N.Y.

AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT

CPI News Briefs

- Processes
- Plants
- Offices
- Companies
- International

Processes

Titanium-palladium alloys with high corrosion resistance will be manufactured by Titanium Metals Corp. of America, under license from the alloy's developer, Union Carbide Metals (*Chem. Eng.*, May 18, 1959, p. 200). Alloy, containing only 0.15% Pd, greatly enhances titanium's resistance to reducing environments such as boiling hydrochloric and sulfuric acids.

Molybdenum oxide process has been patented by Kennecott Copper Corp. Low-grade molybdenite concentrates are roasted for partial elimination of sulfur; roasted product is then reacted with sulfuric acid at about 700 F. in a rotary furnace, converting the molybdenum to soluble sulfates. Product is leached with water and molybdenum values are won from the solution by either ion exchange or solvent extraction. Resulting high-purity oxide can then be converted to metal.

Tin coatings for metal parts can be achieved via a new chemical process developed by Shipley Co., Wellesley, Mass. Firm's Cuposit LT-26 is claimed to produce a stable coating solution that can be used at much lower temperatures than the hot-tin dip process, uses no electricity and contains no cyanide. Protective tin coatings can be used to prevent oxidation, and to whiten copper, copper alloys, lead-tin electroplate and other materials.

New cooler for sintered iron ore—the first of its kind—is operating at the New York Div. of Jones & Laughlin Steel Corp. at Star Lake, N. Y. Built by Dravo Corp., Pittsburgh, unit cools the hot ore by blasts of air as the ore works its way down a vertical shaft. New design permits more gradual cooling—around 1½ hr.—compared with conventional rotary coolers that cool ore for only 15-20 min. More gradual cooling makes the sinter physically stronger. New cooler is part of an over-all system, including Dravo-Lurgi breaker and Dravo-Schenck vibrating screen, that sizes the material from the sintering machines before cooling.

Plants

Aluminum Co. of Canada, subsidiary of Aluminium Ltd., Montreal, Que., is the head of a four-company combine that plans to build a $30-million aluminum rolling mill somewhere in the northeastern U. S. The other three participating firms are **Cerro Corp.** (formerly Cerro de Pasco Corp.), New York; **Bridgeport Brass Corp.,** Bridgeport, Conn.; and **Scovill Mfg. Co.,** Waterbury, Conn.

Capacity of the plant will be 100,000 tons/yr. It will process ingots supplied by Alcan's new plant at Arvida, Que., and output will go to factories of the four participating companies. These factories are at Kingston, Ont.; Warren, Ohio; Fairmont, W. Va.; and Waterbury, Conn.

A major factor in selecting the plantsite will be its geographical position with respect to the other plants involved in the over-all project. Buffalo is reported to be one of the locations under study.

Alcan will furnish $15 million for the facility, and the other three firms will each contribute $5 million.

United Merchants & Manufacturers, Inc.'s chemical division, Valchem, will enter the polyester resin market this year with a new plant at Langley, S. C. Facility is scheduled to start production late this spring with a capacity of 3 million lb./yr.; this figure will be expandable to 12 million lb./yr. of unsaturated resins. Primary markets will be in the Southeast.

Rayonier, Inc.'s Grays Harbor Div. will erect a $2.4-million pulp bleaching plant at Hoquiam, Wash. It will replace existing facilities, increase bleaching capacity to 200 tons/day, and make possible the production of pulps for new grades of paper. Construction is scheduled to start in March.

Dept. of Interior's saline-water-conversion program continues to advance, with news reported recently on two conversion projects. Ground was broken on December 20 for a $1.6-million plant at Point Loma, Calif., that will convert sea water to fresh by flash evaporation. Facility is expected to be in operation by late this year, producing 1 million gal./day. The water will be sold at 20¢/1,000 gal. for municipal use (plant's operating costs, however, will be considerably higher than this figure).

And, Carrier Corp., Syracuse, N. Y., has started operating a 15,000-gal./day pilot plant at Wrightsville Beach, N. C., that makes fresh water from sea water by a freezing process. Company formerly operated the same plant at Syracuse, treating synthetic sea water, and the process it employs is one of a group of freezing processes being considered for eventual use in a 150,000 - 300,000 - gal./day demonstration plant.

Sun Chemical Corp.'s Ansbacher-Siegle Div. has acquired a plant on a 6-acre site in Newark, N. J., where the division will manufacture pigments and pigment intermediates. Production in the new facility is scheduled to start early this year. Ansbacher-Siegle's main plant and offices are on Staten Island, New York, and its pigments operations will be carried out at both locations.

Sun will also establish a corporate research center at Carlstadt, N. J., that will occupy part of a building the firm bought in November. It is scheduled to be ready for use by April.

Donner-Hanna Coke Corp., jointly owned by Republic Steel Corp. and

More CPI News Briefs (continued on page 136)

RED HOT PROBLEM-SOLVER

There are three basic reasons why this brand has been stamped on so many successful projects recently.

REASON NO. 1—Platinum Metals have a superior *combination of properties* . . . resistance to high temperatures, exceptional corrosion resistance, catalytic action.

REASON NO. 2—Platinum Metals *perform* and continue to serve—often where no other materials can endure.

REASON NO. 3—Platinum Metals are *cheaper* than you think, because of their high recovery rate.

We make Platinum Metals in all shapes and forms . . . sheet, strip, foil, wire, tubing, gauze, salts and chemicals. And we operate complete *catalyst* and *scrap recovery* units. Clads and composites also available in many forms.

Bulletin No. P-6 tells our story. Write for it.

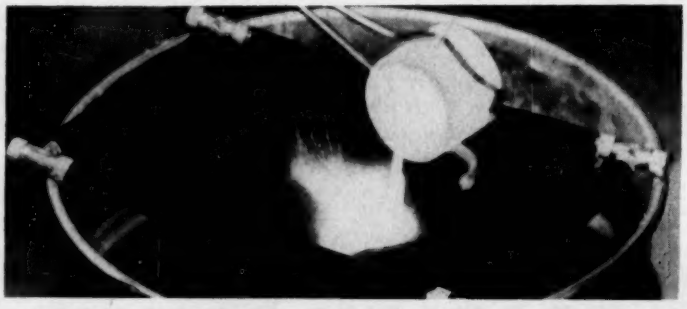
BISHOP

J. BISHOP & CO. *platinum works* / 60 KING STREET, MALVERN, PENNSYLVANIA

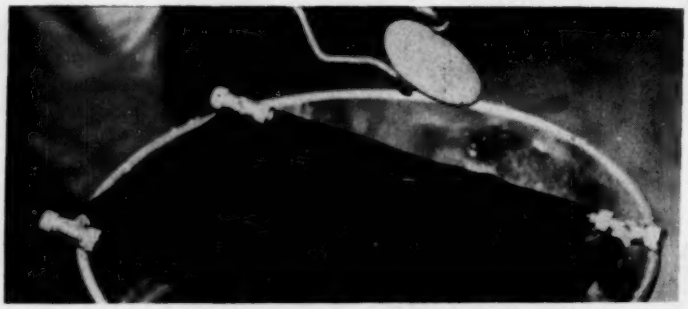
A JOHNSON MATTHEY ASSOCIATE PHONE: NIAGARA 4-3100

"METALS FOR PRECISION AND PERFORMANCE"

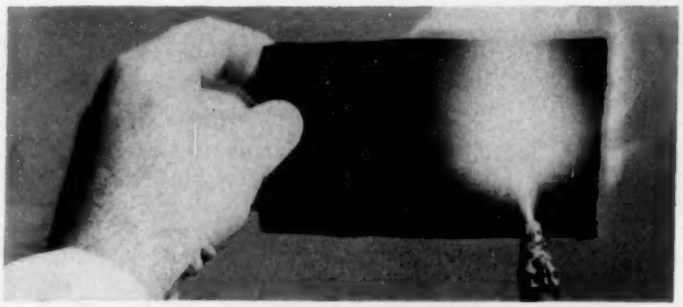
New organic fiber won't melt even at 18,000 F.



Molten steel at 3,000 F. is poured into the new, heat-resistant fiber. The slug solidifies on the fabric without burning through it.



Solidified slug of steel is lifted off. Fabric didn't char or melt while the puddle of molten metal cooled on its surface.



This man's fingers, 3 in. away from the 5,000 F. spot, are quite safe because the fiber lacks thermal—and electrical conductivity.

A new organic fiber, laconically described by Minnesota Mining & Mfg. as a compound of carbon, hydrogen, oxygen and nitrogen, is opening new vistas in high-temperature applications. (Chem. Eng, Jan 9,'61, p. 33)

Called Pluton (after the Greek god of Hades), the fiber has been exposed in a plasma jet to temperatures up to 18,000 F. without melting. Because of its tensile strength and resistance to high temperatures, Pluton will go into the lining of missile motor cases, anti-arc wraps in power plants, fire-protective curtains in mines, steel mills and public buildings.

When reinforced with phenolic resins, this fiber becomes suitable for structural parts of rocket engines and in missile nose cones that must resist extremely high velocities, temperatures and pressures. **Minnesota Mining & Mfg. Co., St. Paul, Minn. 62A**

Fuel anti-icer

Additive eliminates fuel icing in high-performance jet aircraft

A new chemical additive, chosen after scanning hundreds of other compounds, prevents in-flight ice formation in aircraft jet fuel systems. Because jets constantly fly in subzero temperatures, it is quite possible that any water contained in the fuel system may freeze into ice, which can block fuel flow and cause loss of engine power or flameout.

The additive, after exhaustive tests in Boeing B-52's and KC-135's, now has approval of the U. S. Air Force for use by the Strategic Air Command.

According to one Air Force engineering officer, if such an anti-icing additive had been available earlier, the U-2 crash in Russia could have been averted.

Phillips Petroleum developed the additive (PFA 55MB) and won't disclose its composition. But *Aviation Week* through its contacts in the aircraft industry learned that the compound is 90% Cellosolve and 10% glycerine, which makes the additive compatible with the rubber coatings on the B-52 and KC-135 fuel tanks. The Cellosolve—ethylene glycol monoethyl ether, prepared by Union Carbide—is the actual antifreezing agent.

PFA 55MB dissolves mostly in the water that settles out of the fuel as the temperature drops, and it lowers the freezing point of the water almost to the freezing point of the fuel itself.

Some jet aircraft now rely on heaters installed between the fuel tanks and the turbines to raise in-flight temperatures to safe limits. But a very small amount of PFA gives the same protection, and in new aircraft it could eliminate the initial cost, weight, maintenance and in-flight operating expense of heaters. — **Phillips Petroleum Co., Bartlesville, Okla. 62B**

Now...a low-cost Nitride-Bonded Silicon Carbide!

CRYSTOLON* "63"

Now, the best-performing silicon carbide refractory is available at a realistic price! Brand-new CRYSTOLON "63" permits the use of a cost-saving nitride-bonded silicon carbide refractory for hundreds of applications.

Produced by an exclusive Norton process, CRYSTOLON "63" silicon carbide provides all the superior properties of nitride-bonded silicon carbide at a *new low cost!* It has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. In extensive tests, it not only showed excellent resistance to "wetting" by molten non-ferrous metals (aluminum, magnesium, zinc, lead and others) but also to fused salts, such as cryolite!

Use CRYSTOLON "63" silicon carbide as a refractory for handling corrosive salts — as reactor lining — as the *economical* solution to hundreds of tough processing problems. Get complete test results and properties now. Write NORTON COMPANY, Refractories Division, 501 New Bond Street, Worcester 6, Mass.

*Trade-Mark Reg. U.S. Pat. Off. and Foreign Countries

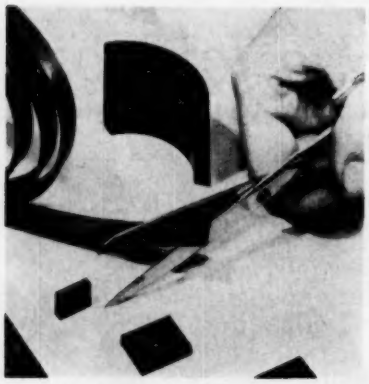
REFRACTORIES

Engineered... R... Prescribed

75 years of

Making better products
...to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes



Magnet

Permanent magnet material is easily cut and shaped.

Rubber-bonded barium ferrite, called Plastiform 1, is a new low-cost magnet that can be readily cut by ordinary tools.

Comparable to sintered isotropic barium ferrite, Plastiform is magnetically oriented, has high coercive forces and an energy product of approximately one million gauss oersteds.

In contrast with sintered magnetic materials, Plastiform is neither hard nor brittle but has a high impact strength and can be easily machined without chipping. It is currently gaining ground in magnetic cabinet latches, holding devices, toys, d.c. motors and gasket inserts.

This new material comes in many forms, such as rings, sheets and strips.—**Leyman Corp., Cincinnati, Ohio.** **64A**

Polyethers

Resins will go into the manufacture of flexible urethane foams.

Based on propylene oxide, two new polyether resins are now commercially available. One, tradenamed Fomez ED-2000, is a polypropylene glycol with an average molecular weight of 2,000. This resin is used for preparing prepolymer flexible foams.

The other, ET-3000, is a propylene oxide adduct of glycerine with an average molecular weight of 3000. It can be used either alone or in combination with the diol ED-2000 in the manufacture of one-shot flexible foams.

Both resins meet the exacting requirements of producers of urethane foam products in the automotive, furniture and bedding industries, and are said to offer high uniformity and excellent processing characteristics.

Present prices range from 22 to 27¢/lb.—**Witco Chemical Co., New York.** **64B**

Cement

Lightweight floor topping resists cracks, cuts installation expenses.

Since its development in Germany about eight years ago, a special anhydrite cement has soared to an annual production volume of 50,000 tons/yr. Now made in the U. S. for the first time, this cement —a processed byproduct of hydrofluoric acid manufacture—goes into floor toppings that actually float over the structural subfloor, eliminating any damage caused by movement of the subfloor.

Called Synthanite, this cement is said to have high strength and negligible shrinkage that, for ordinary floors, allow its installation in 1-in.-thick layers over membrane separators such as impregnated building paper, felt or polyethylene.

In contrast, a floating floor topping of ordinary concrete would require a thickness of 2 to 3 in. with reinforcement, and would weigh 25 to 38 lb./sq. ft. as compared with 12 lb./sq. ft. for a 1-in. thickness of Synthanite concrete.

Expected to reach a 10,000-ton market in America by the end of this year, this product gives a durable and crack resistant underlayer for all floor coverings from asphalt and rubber tile to ceramic and wood floor coverings.

Synthanite topping over insulating concrete helps minimize heat losses through floors and prevents moisture condensation on the surface. And electrical conduits can be safely embedded in the topping because the material is incombustible. — **American Synthanite Corp., New York** **64C**

Insulation

Ceramic is now spun into a heat-resistant fiber

After several years of pilot-plant production and field testing, Fiberfrax ceramic fiber has reached full commercial production.

The material, a mix of high-grade alumina and silica, is heated to 3,900 F. and poured as a molten stream the size of a lead pencil. The stream is struck with a blast of air, or spun, forming light, durable fibers of varying lengths that look very much like white wool but withstand continuous operating temperatures up to 2,300 F.

The fibers are fabricated into

Newsworthy Chemicals

Page number is also reader service code number

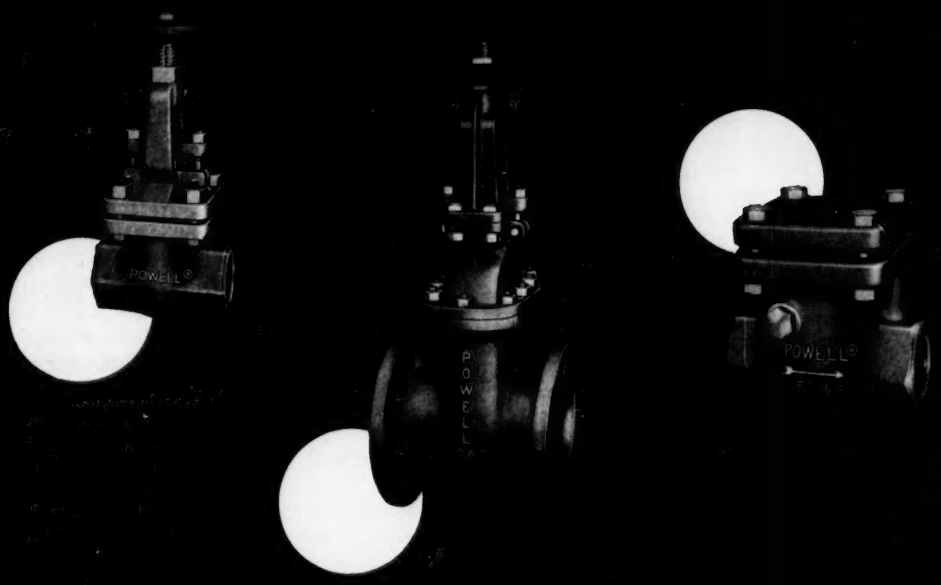
New organic fiber won't melt even at 18,000 F.....62A
Jet fuel additive prevents ice formation in fuel tanks.....62B
Magnetic barium ferrite features ease of cutting.....64A
Polyethers from propylene oxide move in urethane foams.....64B
Lightweight cement cuts installation costs of floor topping.....64C
Ceramic is now spun into a heat-resistant fiber.....64D
Polysulfide modified epoxy combats slippery surfaces.....66A
Alkaline solution quickens stripping of troublesome paints.....66B
Li-Al tri-t-butoxy hydride is now available.....66C
Furfural alcohol and glass fibers team up to fight corrosion.....66D
Epoxy curing agent is also a rust inhibitor.....66E
Fume suppressors improve chromium plating baths.....66F

For more details use Reader Service Card

POWELL FUL PERFORMANCE!

In creating their modern wonders — the chemical and process industries are the miracle makers of the 20th century. And in this magic crucible, Powell valves are used to control the flow of corrosive fluids—acids, alkalies, organic solvents, and gases . . . often under the most severe conditions.

Powell corrosion-resistant valves can be de-

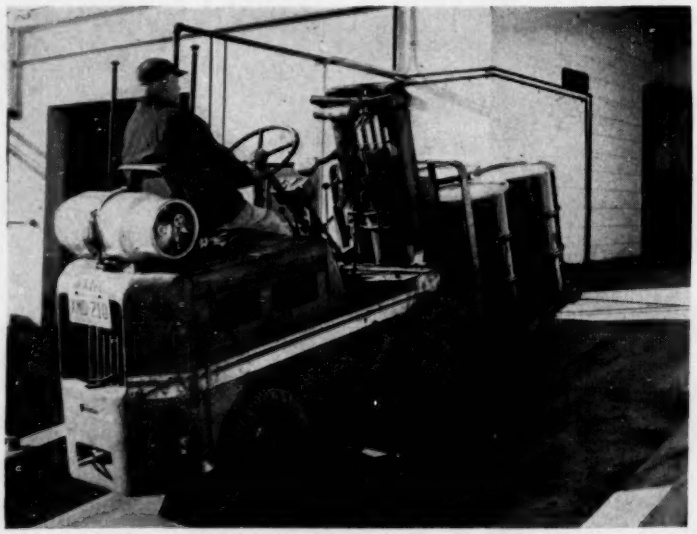


115th year of manufacturing industrial valves for the free world

POWELL CORROSION RESISTANT VALVES

THE WM. POWELL COMPANY • CINCINNATI 22, OHIO

Epoxy adhesive combats slippery surfaces



Polysulfide modified epoxy, sprinkled with fine or coarse abrasive grains, gives antislip qualities to floors, decks, ramps, docks, elevated walkways and stair treads.

This product, called Ruffin, is in the form of a brush-on or roll-on finish that adheres strongly to wood, metal, cement and floor tile, providing a long-lasting, sure-grip surface for the protection of plant operators. Effective even when laid down approximately 10 mil thick, Ruffin is particularly suited for oily or slick surfaces exposed to the weather.— **Custom Abrasive Products Co., Trenton, N. J.** **66A**

over 40 forms such as blocks, sheets, paper, textiles, blankets, rope and molded forms.

Fiberfrax also goes into linings for oil- and gas-fired furnaces, components for processing molten aluminum and high-temperature gaskets and packing.— **The Carborundum Co., Niagara Falls, N. Y.** **64D**

Paint stripper

Alkaline solution quickens stripping of troublesome paints.

Zinc-clad steels have recently attained major status in the manufacture of corrosion-resistant articles because these steels—whether electrolytic or hot dipped—have shown a great resistance to salt spray and humidity, when they are phosphated, primed and painted.

On the other hand, economical and fast stripping of paint from the zinc-clad steels, without damaging the zinc, has become an ever increasing requirement.

A mixture of strongly alkaline salts, Chemclean 441B, used at 8 to 16 oz./gal of water at 180-200 F., can quickly and completely strip the zinc-clad steels, leaving a surface ready for immediate repainting without further treatment.

Salt spray tests have shown that after stripping the zinc surface has the same corrosion resistance as the original phosphated sheet. Chemclean 441B will remove alkyds, melamines, phenolics, urea formaldehyde resins and other synthetic paints.— **Chemclean Products Corp., College Point, N. Y.** **66B**

Briefs

Lithium aluminum tri-t-butoxy hydride is a new complex that reduces acid chlorides to aldehydes. This product, now available in laboratory quantities, also reduces steroid ketones to hydroxy derivatives.—**Metal Hydrides Inc., Beverly, Mass.** **66C**

Modified furfural alcohol reinforced with glass fibers, Bonate CF-9070, is a corrosion-resistant plastic that sustains continuous operating temperatures to 300 F. Reported as highly successful in the processing of tanks, pipes and ducts, Bonate is nonflammable and resistant to practically all acids, solvents and even hot concentrated NaOH and KOH solutions—**Carl N. Beetle Plastics Corp., Fall River, Mass.** **66D**

Epoxy curing agent, Alkendic anhydride, prolongs pot life, gives easy mixing, lower density and low vapor pressures during cure, thereby reducing material losses. Cured products have high heat-distortion temperatures and low shrinkage. This anhydride can also be used in alkyd resins, rust inhibitors and as a chemical intermediate. — **Amchem Products Inc., Ambler, Pa.** **66E**

Control of objectionable fumes and spray escaping from chromium plating baths, can be effectively obtained with Unichrome SRHS (self-regulating, high-speed) compounds. Supplied in pelletized form, these compounds combine in a single product the necessary chromic acid, a plating catalyst, and a chemical fume suppressor that acts as a built-in ventilation aid.—**Metal & Thermit Corp., Rahway, N. J.** **66F**

For More Information about any item in this department, circle its code number on the Reader Service Postcard (Page 165).

Chemicals
AND THE SPACE AGE

Harshaw Synthetic Crystals are not only being used to explore the vagaries of space, but these same crystals are probing deep into the core of the earth. A short while ago two customers with totally different problems visited our Crystal Department on the same day to tell us of new experiments with synthetic crystals.

In one case, a Harshaw Scintillation Crystal was sent aloft in a balloon to the highest altitude ever reached by a lighter than air craft. The crystal was used in an instrument to measure radiation in the upper reaches of the atmosphere.

The other crystal was lowered into an oil well to a depth heretofore unexplored. Here again, the crystal was used in a detection mechanism to explore the types of rock formation by radiation.

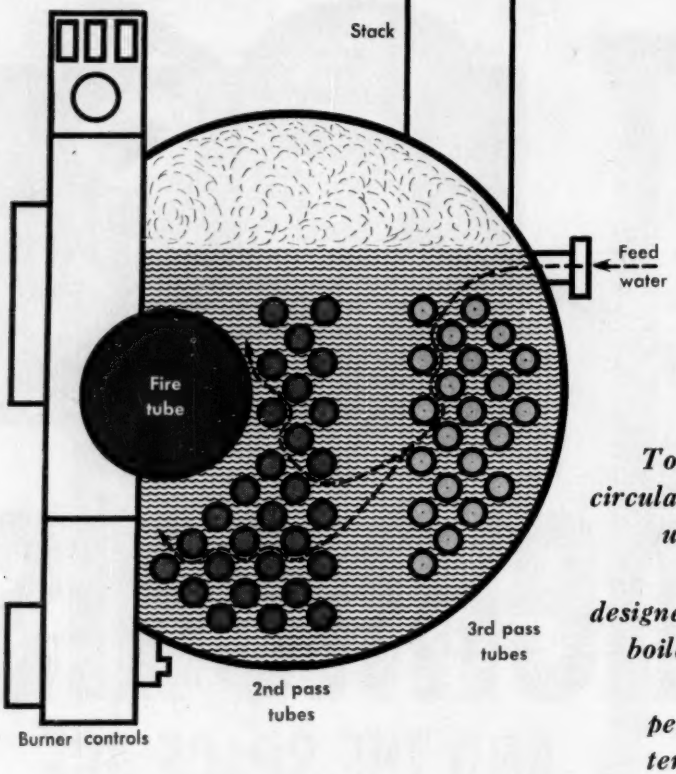
Harshaw's Synthetic Crystals are continually being used in new areas. The Synthetic Crystal Division is one of the ten divisions of Harshaw devoted to the advance of science and industry through the use of chemicals.

Product Manufacturing Divisions:

FLUORIDE	OPTICAL CRYSTAL
ELECTROPLATING	PIGMENT
DYES AND FINE CHEMICALS	CATALYST
METALLIC SOAPS	CERAMIC COLORS

HARSHAW

THE HARSHAW CHEMICAL COMPANY
1945 EAST 97th STREET • CLEVELAND 6, OHIO



To obtain efficient water circulation and optimum heat utilization, put the fire tube on the side, say designers of a new packaged boiler. Same design, used for hot water boiler, permits lower operating temperatures in this . . .

NEW LOOK IN STEAM GENERATORS

A new packaged automatic boiler, the first with its fire tube on the side, is the latest result of the search to find more efficient ways to generate steam. According to Orr & Sembower, Reading, Pa., who developed the new boiler, the side-located fire tube provides the most efficient circulation of water of any of many designs tested.

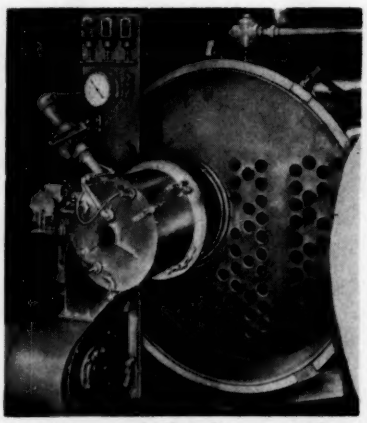
Side location of the furnace provides other benefits: it eliminates danger of heat damage due to stagnant water and sludge at boiler bottom, makes fireside and water-side surfaces easy to inspect, and permits easy accessibility without disturbing burner, wiring or piping.

▶ **Three-Pass Arrangement** — The fire tube and boiler tubes are arranged so that burner gases make three passes through the boiler before reaching the stack. With hottest gas originating at one point and gas temperature gradually decreasing to the end of the third pass, this design permits boiler feed injection and natural thermal circulation to augment each other.

As relatively cool feed water enters the boiler from the side, it is directed down through the third (coolest) pass. The water follows the normal downward movement of natural circulation to the bottom, rises through the second pass and finally reaches the furnace area.

Along with the unique furnace design, O&S has incorporated a new burner that is convertible in the field to burn either gas or oil. The oil burner may be quickly converted to a gas burner or a combination unit, and vice versa, according to the manufacturer.

▶ **Good Efficiency** — Boiler plus burner design add up to an overall heating efficiency of 83% (of theoretical) using No. 6 fuel oil and about 80% (of optimum) with gas and lighter oils. The gas burning system will operate dependably on gases with varying densities and heating values. Forced-draft air is used for combustion.



Open door on boiler shows actual arrangement of fire and boiler tubes.

M
KELLOGG
W

U.S.I.

How Plant Engineering Teamwork Increased Polyethylene Capacity 1200% In 5 Years

In less than 5 years, U.S. Industrial Chemicals Company has increased its capacity for polyethylene from 25 million pounds to 300 million pounds—to become the world's second largest producer of this popular plastic material.

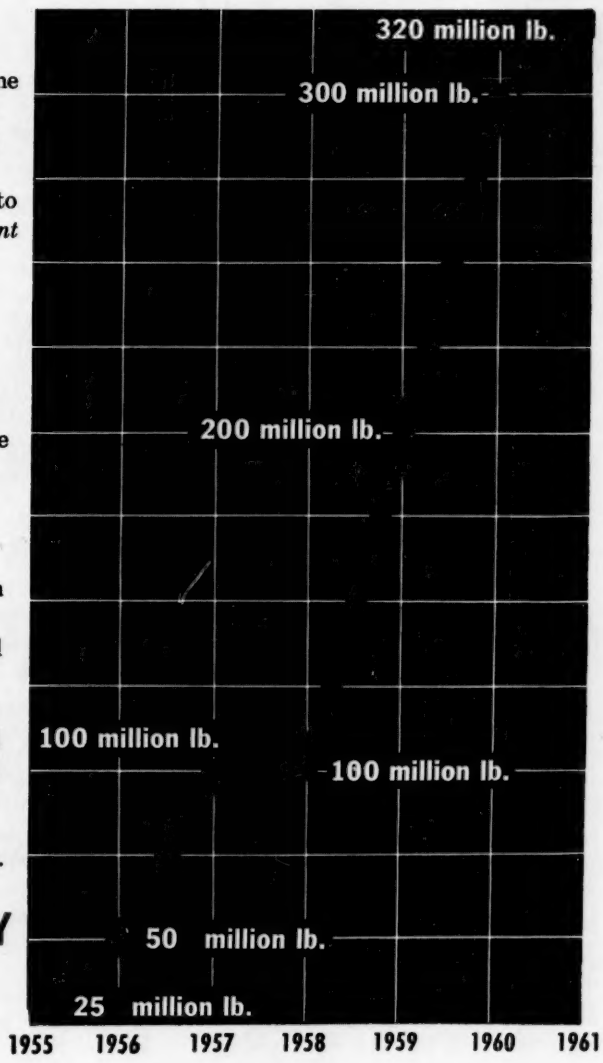
Engineering and building all the various facilities to attain this position so rapidly, *with optimum investment for each project,* is a story of continuing teamwork between U.S.I. and The M. W. Kellogg Company.

It started in 1955, when Kellogg was given the over-all responsibility for U.S.I.'s first PETROTHENE® polyethylene plant, a 25-million-pound grass roots project in Tuscola, Illinois.

In 1956, Kellogg was commissioned to double the capacity of the Tuscola plant—and to double it again in 1957.

In 1959, the same close teamwork put a brand new 75-million-pound PETROTHENE plant on stream in Houston, Texas. This was increased from 75 to 100 million late in 1959. And in 1960, it doubled *this* plant's output—bringing U.S.I.'s total capacity to 300 million pounds.

If you are planning new or expanded production facilities at home or abroad, Kellogg would be glad to show you how teamwork—which coordinates all engineering, procurement, and construction steps under one integrated international management—could work to *your* company's economic advantage.



THE M. W. KELLOGG COMPANY

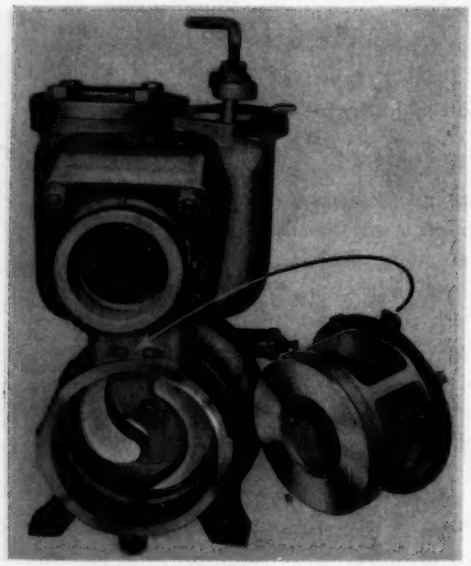
711 Third Avenue, New York 17, N. Y.
A subsidiary of Pullman Incorporated
Offices of Kellogg subsidiary companies are in Toronto, London, Paris, Rio de Janeiro, Caracas, Buenos Aires

Called the Model PF, new boiler permits quick access to heating surface. Hinged front cover, with quick-opening fasteners (no bolts) can be opened in less than two minutes. The rear cover is divided for easy handling. Each section is quick opening; when closed, each one forms a separate seal for its section of the back tube sheet, thus eliminating any need for internal baffles.

Standard rear-door construction is dryback; a prefired high-temperature refractory liner is backed with lightweight insulation. Optional wetback design allows the same ease of access for inspection while adding heating surface and eliminating refractory.

Using the same basic construction, O&S also has hot water and steam atomization models. Hot water unit employs same burner, differs only in location of outlet and return piping connections. Baffle arrangement diffuses return water away from hot surfaces.

Steam boiler is available in five sizes: 50, 60, 70, 80 and 100 boiler hp. Hot water and steam atomization models also come in all five sizes. — **Orr & Sembower, Inc., Reading, Pa.** **68A**



End plate comes off in a jiffy if oversize solids must be removed. Note space between vanes.

SLURRY PUMPED, EVEN IF IT CONTAINS SOLID CHUNKS UP TO 3-IN. DIA.

Two-vane impeller accepts large solids, doesn't clog.

If your process has a liquid stream containing solid matter up to the size of a tennis ball, here's a pump that can handle it. Previously used mostly for pumping sewage wastes, this self-priming centrifugal is designed to pass solids from 1½ to 3-in. dia.

Impeller design makes possible the handling of large, solid particles. Two-vane construction provides a channel through which the solids can pass without clogging the clearances around the impeller's periphery. And when the pump does plug up, you can open, clean, and put it back on the job in minutes without disturbing piping, via a removable end plate.

For suction lift, the pump is self-priming, after initial use has filled the chamber with liquid. A check valve in the suction inlet (which is shown just above the impeller chamber in the illustration) keeps liquid in the chamber when the pump is shut down. Upon restarting, this liquid is sufficient to fill impeller, entrapping air and vapor so that impeller can create a vacuum sufficient for up to 20 ft. of static suction lift, depending on model and pump speed.

To prevent binding of the impeller shaft in slurry pumping service, the back of the impeller is fitted with integral cutter bars that keep solids away from the shaft. The pump also maintains negative seal pressure at the shaft seal by means of pressure relief holes located near impeller's eye.

Five models in the line have capacities from 100 to 1,000 gpm., at heads up to 110 ft., depending on pump size and speed. Construction is in cast iron, bronze or Type 316 stainless steel. Shaft seal is double, grease-lubricated type or packing gland and lantern ring.— **The Gorman-Rupp Co., Mansfield, Ohio.** **70A**

Conveyor scale

Bulk materials are automatically weighed, measured, controlled.

Are you transporting any type of bulk material on a conveyor gallery? Is it hard to find out how much material you're handling? A new conveyor scale automatically weighs, measures, meters and/or controls bulk material flow on conveyor belts, according to the manufacturer.

Called Vey-R-Weigh, it is adaptable for measurement, control and recording operations such as continuous product inventory, blending of additives, segregation con-

Which of these 3 products and services can yo

New Cold Caustic Bleach Process

Looking for a way to use greater amounts of low-cost, more plentiful pulp—without capital investment for bleach equipment? Then let a Becco Sales Engineer show you our new technique* which allows you to bleach in the same equipment regularly used for the manufacture of cold caustic pulp.

In this new process, peroxide bleach liquor is added at the Bauer Refiner, and bleaching occurs during the refining operation. Bleach response depends on refiner densities.

Up to 20 points brightness increase has been obtained in commercial operations to date, and with no additional steam costs, no holding time, and no excessive chemical costs.

Becco can assist you immediately in setting up a production run and evaluating results. First step: use the coupon to let us know you're interested.

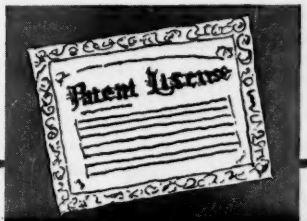
*—Patent Pending

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York
Dept. CE-H

Gentlemen:
Please have a Sales Engineer give me more information on Becco's Cold Caustic Bleach Process.

NAME_____
FIRM_____
ADDRESS_____
CITY_____
ZONE____ STATE_____



"Enclosing $1.00 — Send Patent License"

Well, perhaps there's a little more to your gaining use of Becco patents than just mailing your dollar in, but not much more. And certainly, no more money. The $1.00 really does cover it.

Becco has lots of patents, granted as a result of innovations in the use of Hydrogen Peroxide and other Peroxygen chemicals developed in Becco's Research Laboratories. But they don't do us a whole lot of good locked tightly in our safe. So, we long ago adopted the following policy:

If one of our patents can help you, we'll be glad to license the rights to you **perpetually,** for just one dollar. You get a nice certificate, incidentally, to cover the legalities, but more important – you also get free our complete engineering help in setting up your process, handling the material, maintenance, etc., etc.

What do we get? You as a customer – we hope – but there's no obligation on your part. Just seems to work out that way, though – when we know enough about a particular peroxygen to hold a patent on its use, chances are we've also learned enough to produce it purer than anyone else. You benefit from this; we do, too.

Use the coupon below to ask for a Sales Engineer – or our list of patents – that may help you solve an important problem.

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York
Dept. CE-F

Gentlemen:
Please send your list of patents available on the use of
- ☐ Hydrogen Peroxide
- ☐ Peroxygen Chemicals
- ☐ Persulfate Chemicals
- ☐ Please have a Sales Engineer call.

NAME_____
FIRM_____
ADDRESS_____
CITY_____
ZONE____ STATE_____

Problems in handling Hydrogen Peroxide

?

Becco's Four-Fold Engineering Service Program—offered free—includes:

1. Comprehensive survey of your facilities.
2. Specific proposal with recommendation of proved equipment and where it is obtainable.
3. Installation supervision by Becco.
4. Periodic inspection and permanent service.

Can you use this free Becco help, based on more years of experience with bulk handling of H_2O_2 than any other manufacturer? Use the coupon to let us know.

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York
Dept. CE-B

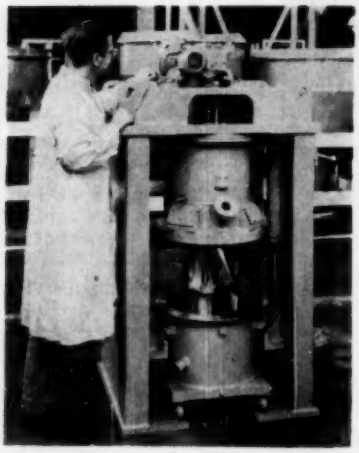
Gentlemen:
Please tell me more about your Four-Fold Engineering Service.

NAME_____
FIRM_____
ADDRESS_____
CITY_____
ZONE____ STATE_____

trol, bulk density determination and control of feed rates to processing equipment.

Unit has a carriage that supports one conveyor idler, weighing the belt and material it carries. A remote indicating and recording instrument, which may be located up to 500 ft. from the carriage, contains adjustments for zero and calibration. Standard models have a capacity from 8.6 to 250 lb./ft. of belt.

Various types of controls can be provided for remote recording by tape or punched card readout. Unit is constructed to take large overloads without being injured. — **Ramsey Engineering Co., St. Paul, Minn.** 70B

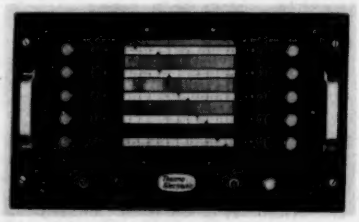


Vertical mixer

Production is speeded with a removable, jacketed mixing can.

Said to be particularly suitable for pilot-plant operations, a new vertical planetary mixer uses jacketed mixing cans, through which an operator can circulate either water or 80-psi. steam. Can, with casters on the bottom to facilitate handling, can be removed from mixer for discharging and cleaning while another is substituted, thus minimizing production downtime.

Mixing is accomplished by double planetary motion of two stainless steel agitator blades that operate at a differential speed of 2:1. Stainless cans hold 50-70 lb. of material/batch. — **Baker Perkins Inc., Saginaw, Mich.** 72A



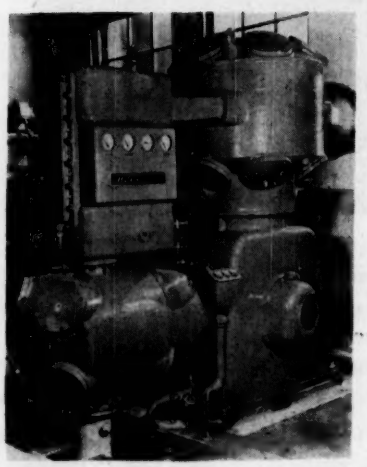
Multipoint controller

Automatic two-position control possible for 10 processes.

This new multipoint temperature controller is said to provide automatic two-position control for up to 10 separate processes, can serve as a single-point controller, a five-point, three-position controller and a manual balance indicator. Points not being used for controlling multiple-temperature processes can monitor other processes.

In operation, input signals, scanned in sequence at 3 sec./point, are compared to slide-wire control settings. Deviations are amplified to provide corrective action through relays connected to the processes under control. All controls and switches are located on front panel, where white lights show scanning position, red lights show process conditions, and knobs set control points quickly.

Unit, combining a null-balance potentiometer measuring circuit with an electronic control system, is suited for situations requiring off-on control. Calibrated range scales are available for all standard thermocouple materials.— **Thermo Electric Co., Inc., Saddle Brook, N. J.** 72B



Air compressor

Heavy-duty unit is designed for three-shift operation.

Capable of delivering 2,280 cfm., this air compressor is a two-stage, water-cooled unit designed for heavy-duty, round-the-clock service. It is said to eat up far less power than most equal-size units.

The 11,700-lb. machine is rated for working pressures of 125 psi. Short-stroke mechanism in an L-arrangement of cylinders provides high capacity-to-weight ratio. Equipped with a water-cooled intercooler and automatic condensate drain valve, the compressor comes as a complete unit. Installation involves bolting the machine to a steel frame that is preset in a concrete foundation. — **Atlas Copco, New York.** 72C

Polymer experimenter

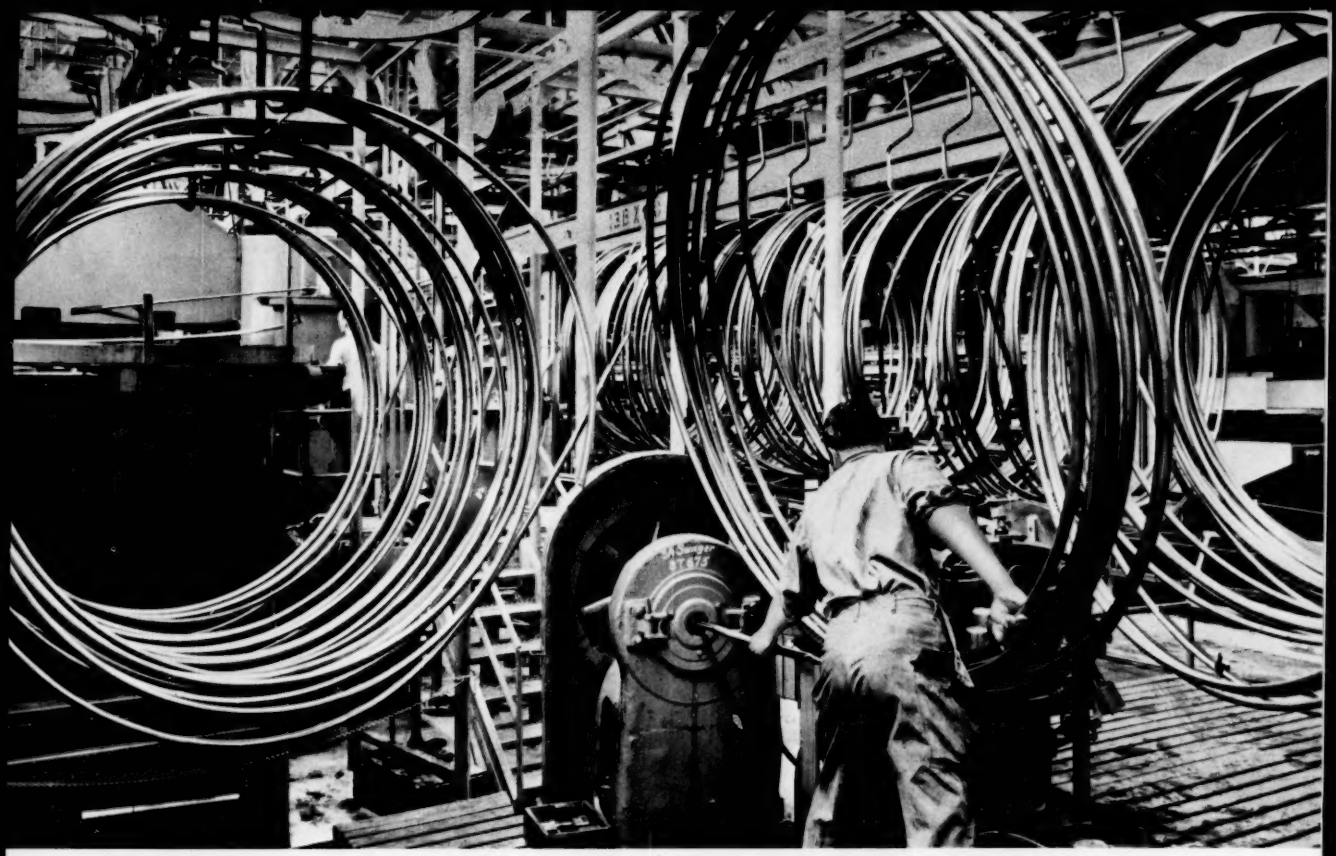
Forming machine investigates characteristics of polymers.

Described as an experimental spinning and drawing machine, unit is designed for investigations of melt or solvent polymer spinning. Small quantities of polymers (25-200 g.) can be run through the device at speeds as high as 1,500 yd./min.

Both spinning head and draw

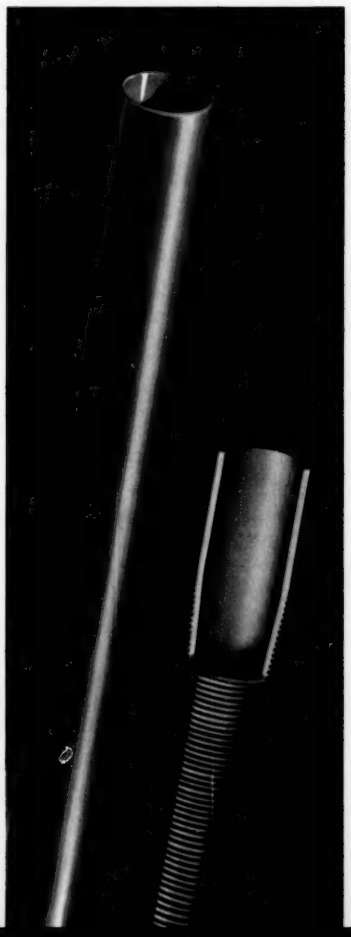
More New Equipment (continued on page 154)

For More Information about any item in this department, circle its code number on the Reader Service Postcard (Page 165)



things you should know about

WOLVERINE TUBE



You know what they say—about change being the father of progress.

Well, that's the way it is at Wolverine Tube and we'd like to tell you about some of the new things going on at Wolverine.

For example, Wolverine recently completed a multi-million dollar modernization program at its Detroit, Michigan plant to serve its customers faster and better. New machinery and new tube-making techniques have made this plant one of the most modern in North America. Wolverine also operates large, modern plants in Decatur, Alabama and London, Canada.

There are new things afoot metalwise at Wolverine, too. In addition to copper and aluminum, Wolverine Tube now works in such metals as titanium, zirconium, columbium, tantalum and molybdenum. Wolverine considers this work so important that it has opened a new plant in Inkster, Michigan (Suburb of Detroit) devoted solely to manufacturing and development of these special metals . . . with specific emphasis on titanium and zirconium. It's the result of an extensive research program started many years ago, and it gives Wolverine customers a big edge when they require an experienced tubing and fabrication source for tomorrow's metals—TODAY.

Also, to insure top-flight sales service, Wolverine has expanded its nationwide sales staff to include a number of highly trained Heat Transfer Specialists. These men, along with other members of Wolverine's Field Engineering Service, are specialists in all phases of tubing selection and application, particularly in the field of heat transfer. Their services are available at all times . . . you only have to ask.

So . . . if your company is looking for the finest of tubing and the finest of service, you'll find both at Wolverine Tube where "improvement is a continuing program".

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.

DEPT. J, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.
Manufacturers of Quality-Controlled Tubing

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

BUY WOLVERINE HEAT EXCHANGER TUBE . . . the product of EXPERIENCE

Experience, dependability, engineering, research – if these are the things you look for when specifying heat exchanger tube you'll find them–in full measure–at Wolverine Tube. You'll find, in addition, a wide selection of tubing types–each designed to help you increase heat transfer efficiency. These tubes are illustrated and described on this page. You can choose any . . . or all of them . . . secure in the knowledge that no finer tubing is made. May we have your next order?

PRIME SURFACE TUBE

Wolverine prime surface heat exchanger tube is available in a wide range of sizes in copper, copper alloys and aluminum alloys. It is produced to ASTM Specifications B-111.

DUPLEX PRIME SURFACE TUBE

Composed of inner and outer tubes of dissimilar metals this tubing is specifically designed to handle two different corrosive conditions at the same time. The metal combinations can be those required to combat your corrosion problems.

WOLVERINE TRUFIN®—THE INTEGRALLY FINNED TUBE

Wolverine Trufin — the original integrally finned tube is manufactured in 7 different types. It is available in external helical low or high fin form or with internal, longitudinal fins. Your Wolverine Sales representative will give you the *complete* story — just ask him next time he calls.

WOLVERINE U-BEND PALLETS

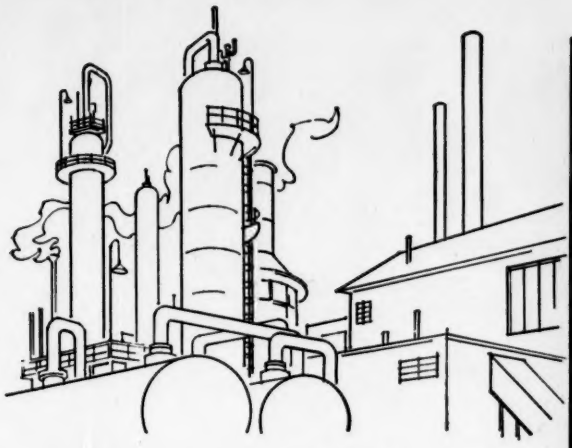
Here is real convenience. Working to your specifications, Wolverine prefabricates these tubes and ships them to you in disposable box-type pallets — *in* the exact order of unit installation. They're real time savers that also help you reduce tube inventory. Wolverine U-bends are available in both finned or prime surface form.

WOLVERINE FIELD ENGINEERING SERVICE

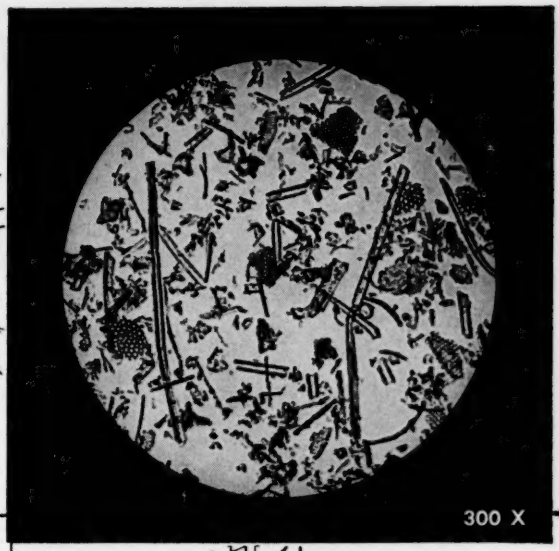
This is a Wolverine "extra"—a staff of highly trained tubing technicians, ready at all time to help you solve heat transfer problems dealing with tubing alloys, corrosion or design. Just ask for their services . . . there is no obligation.

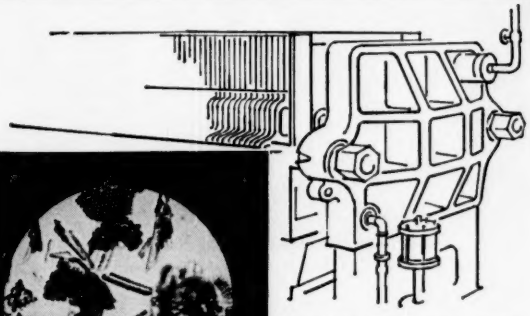
WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. J, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.

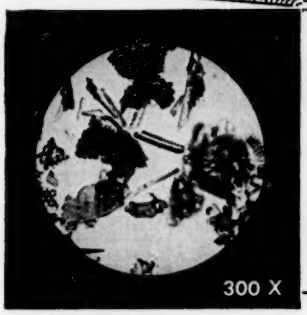
PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES
Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.



For flow rate plus clarity—Hyflo Super-Cel has the right combination of large and fine particles. Heavily used in chemical processes such as caustic soda production.

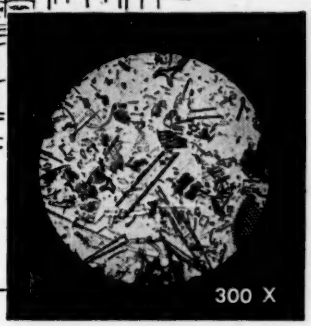






For fast flow rates—Celite 545 has a higher proportion of coarse particles. Frequently used for clarification of resins and other viscous liquids.

For maximum clarity—Filter-Cel has a relatively fine particle size distribution. Used in producing lard, salad oil, other hydrogenated oil products.



In diatomites, Johns-Manville precision processing works for you

Celite has the exact grade for every filtration need from fast flow rate to maximum clarity

Study samples of various filtration grades of Celite* diatomite with the unaided eye. Rub them between your fingers. One grade looks, feels very much like another.

Then compare these grades under the microscope. Each has its own distinctive particle size distribution. Each is precision-milled to fill the most exacting filtration requirements, ranging all the way from maximum flow rate to maximum clarity.

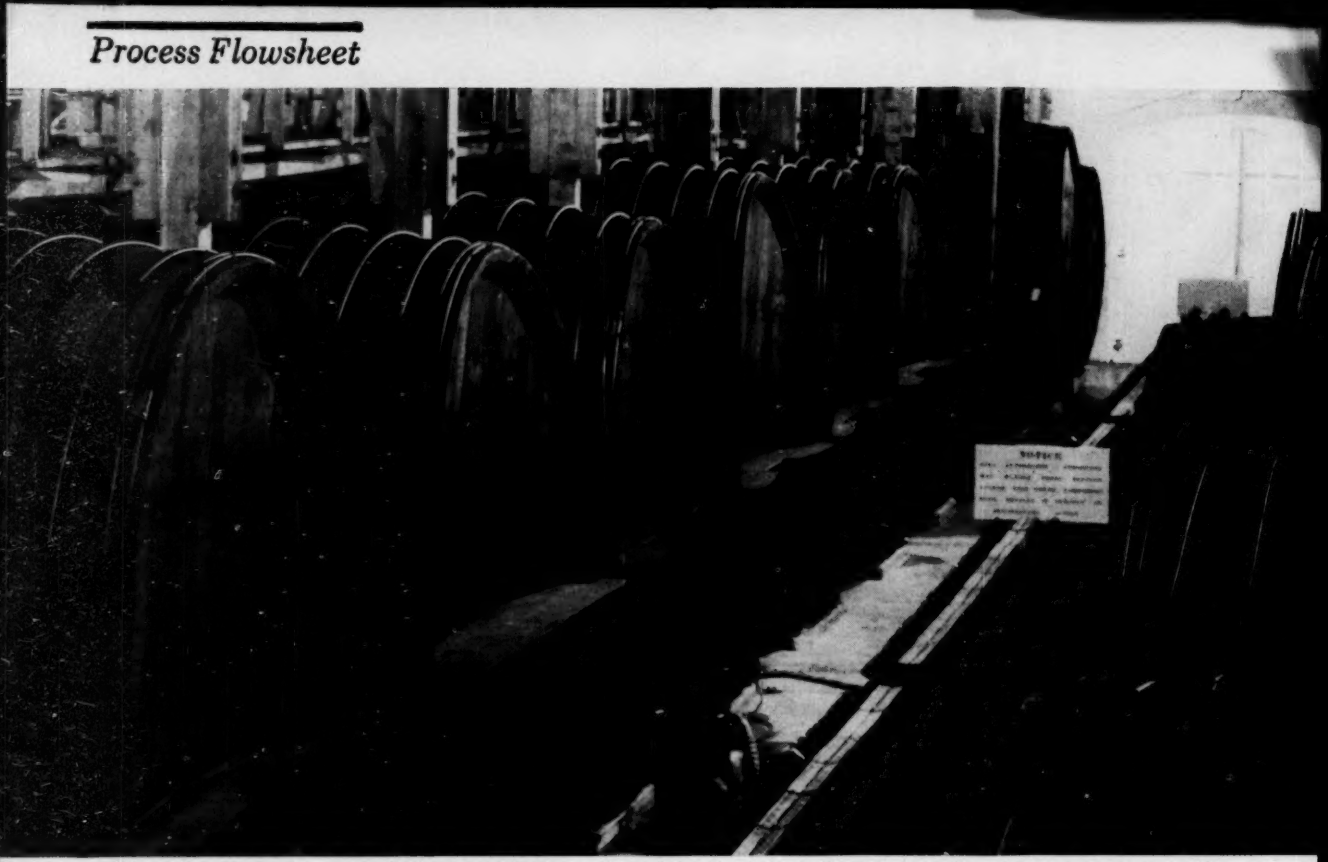
Celite 545, for example, with a higher proportion of large to fine particles, is used to remove large suspended impurities at maximum flow rates. *Hyflo Super-Cel®* has a balanced particle size distribution, combines good liquid clarity and moderate flow rate. But *Filter-Cel®* has a much higher ratio of small particles, is tailored for use where high clarity outweighs flow rate.

Whatever your filtration problem—Johns-Manville can furnish the "right" grade for the job. You have a choice of 9 intermediate grades *plus* many special grades. Each comes from the largest and purest commercially available deposit. Each is processed and graded at the same plant under the same uniform conditions.

For information on specific filtration or mineral filler problems, talk to your nearby Celite engineer, or write to us. Johns-Manville, Box 14, N. Y. 16, N. Y. In Canada, Port Credit, Ont.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products

JOHNS-MANVILLE



Oak tanks are used to age select wines. Center rack contains bottles of champagne undergoing second fermentation.

Winery Keeps Age-Old Process Current

Here's a look inside Roma Wine Co.'s Fresno, Calif., winery, illustrating how progressive winemakers have modernized their ancient art in keeping with advances of chemical technology.

C. HAVIGHORST, *McGraw-Hill World News: Los Angeles*

Making wine and other fermented beverages is among the most ancient of chemical processes, dating back centuries before the Christian era. In line with this tradition-breeding status, winemakers have generally been slow to incorporate modernizations into their art, clinging to the philosophy that process revisions might subtly harm the excellence of their product.

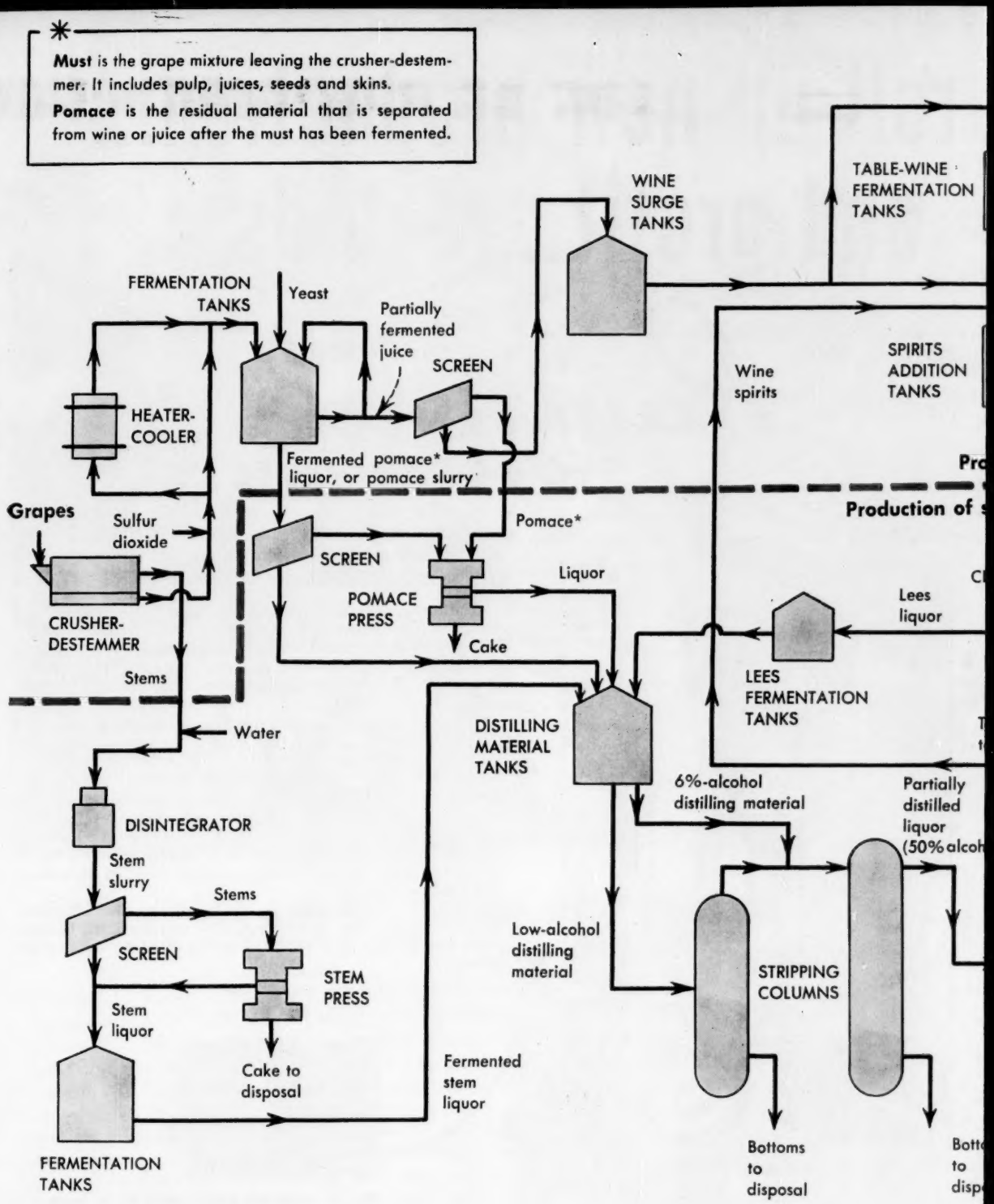
However, even winemaking is bowing to the modern emphasis on science and technology, and the past two decades have seen the industry introduce a number of refinements and improvements.

A good example is provided by Roma Wine Co., Fresno, Calif., subsidiary of Schenley Industries, Inc. Roma operates two wineries, a large one at Fresno and a smaller one at Kingsburgh, Calif., and its total annual production, measured by grape "crush," is 80,000-100,000 tons of grapes. The large Fresno plant is regarded as one of the industry's more progressive wineries, and its management has applied modern technology to winemaking as quickly as economics have permitted.

For instance, the plant is now revising its table-wine aging tanks to accommodate a surface blanket of carbon dioxide, for better preservation of wine quality. Among other recent advances: an ion-exchange system to remove calcium and potassium traces from wines, an automatic control panel for distilling operations, and establishment of a voluntary raw-materials-inspection station.

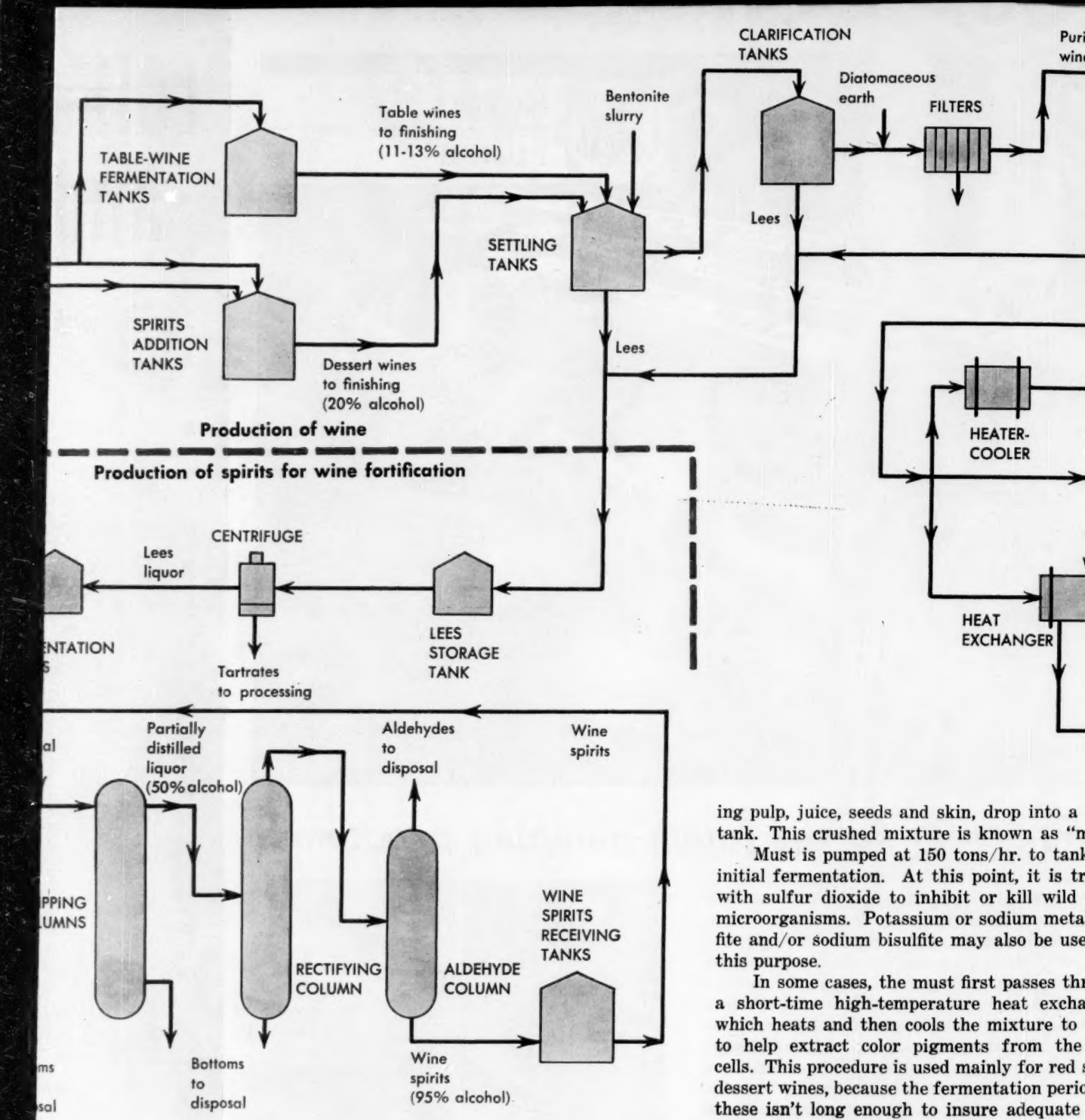
▶ **Output**—Roma's production consists mainly of

Unfold flowsheet →



white and red table wines, dessert and aperitif wines, and sparkling wines and champagnes. The Fresno plant's basic operation produces the table wines; dessert wines are made by fortifying partially fermented table wine with distilled spirits, and the sparkling beverages are produced by subjecting wine to a second fermentation under pressure, either in individual bottles or in bulk.

One basic procedure is used for both white and red table wines, except that for red wines the grape juice, pulp and skins are fermented together, whereas for white wines the juice is separated and fermented free. Shown above is the sequence for red wines, including red dessert wines.



ottles or in bulk. or both white and or red wines the rmented together, uice is separated e is the sequence ert wines.

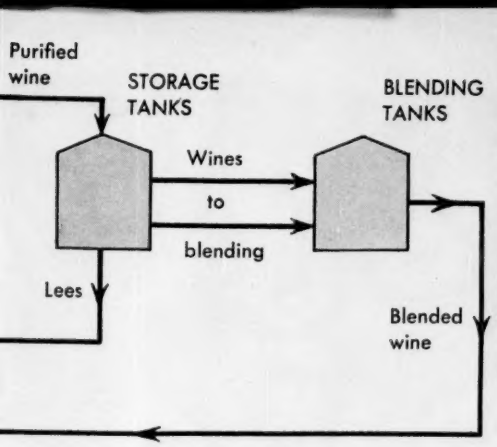
▶**Start with Grapes**—Grapes are examined by state and county inspectors upon delivery to the winery, and those that are acceptable go to one of two crusher-destemmers, which consist of a rotating arrangement of paddles inside a perforated cylinder. Stems leave the end of the cylinder and are sent to processing; the crushed grapes, including pulp, juice, seeds and skin, drop into a tank. This crushed mixture is known as "m

Must is pumped at 150 tons/hr. to tank initial fermentation. At this point, it is tr with sulfur dioxide to inhibit or kill wild microorganisms. Potassium or sodium meta fite and/or sodium bisulfite may also be use this purpose.

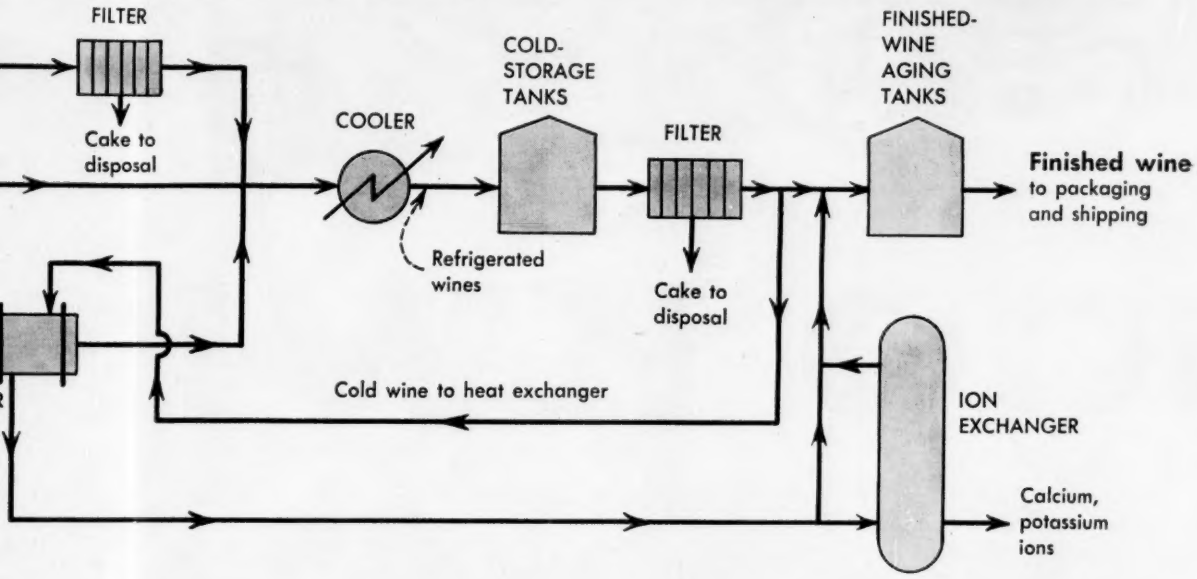
In some cases, the must first passes thr a short-time high-temperature heat excha which heats and then cools the mixture to to help extract color pigments from the cells. This procedure is used mainly for red dessert wines, because the fermentation perio these isn't long enough to insure adequate extraction by itself.

▶**Ferment**—Roma uses the wine yeast *Sa romyces ellipsoideus* for fermentation starter, ally as about 5% of the volume of the Fermentation proceeds at controlled temper —below 85 F., to retain flavor characteristics

Initial fermentation is considered com when the sweetness of the mixture is 1° as r ured on the Balling scale (this corresponds rou



Distillation units produce wine spirits and beverage brandy.



to 1 gm. sugar per 100 cc. solution). When making dessert wines, however, the fermentation is arrested sooner—after sugar content has been reduced to about 50% of its original level.

The liquid is strained from residual solid material (known as pomace). If the product is to be table wine, the liquid then goes to final fermenters where it is fermented until sugar content is under 0.3% and alcohol content is 11-13%. If the product is to be dessert wine, the liquid goes instead to spirits-addition tanks, where it is combined with 191-proof wine spirits to bring alcohol content of the mixture to about 20%. The dessert or table wine is then clarified.

▶ **Finishing**—Production of finished wine starts with careful, expert blending of clarified wine stocks. After the desired blend has been prepared, it goes to finishing steps.

Heating and filtration are used to remove excess proteins, which could cause cloudiness. Pasteurization kills undesirable wine yeasts or bacteria. And all wines are refrigerated, to insure cold-stabilization and obviate quality changes when exposed to varying temperatures.

If required, the wine is subjected to ion exchange so that tartrates won't precipitate. Finally, it goes to aging tanks. Over-all production, including aging, may require over two years before the wine is ready for shipment.

▶ **Making Spirits**—Roma utilizes both the stems and residual pomace from fermentation, processing them to wine spirits that are then used to produce the dessert wines.

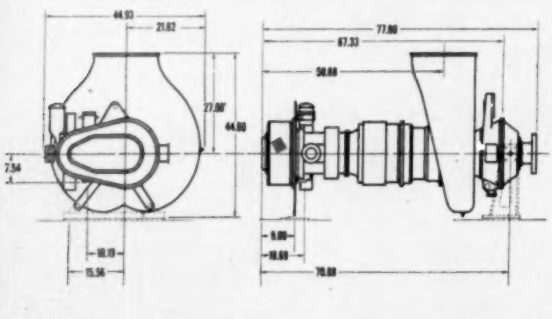
Stems from the destemmer are combined with water, disintegrated and pressed, and the resulting liquid is fermented. And, the pomace is subjected to fermentation, washing and pressing. Liquid from all these operations goes to distilling material tanks and is subsequently distilled to produce 191-proof wine spirits. This is stored in a bonded warehouse, withdrawn as needed for making dessert wines.

Roma also makes beverage brandy, by similarly distilling 12%-alcohol white table wine. Overhead from the stripping column is about 80-100 proof; product of the rectifying column is 130-169 proof. In following steps, this brandy is diluted with deionized water to 80-100 proof before it is shipped.

800 KW!

Solar industrial gas turbine generator sets ideal for peak loading or constant duty

Versatile, compact industrial generator sets powered by Solar's T-1000 gas turbine engine have a nominal rating of 800 kw. They are ideal for either peak loading or constant duty electrical power applications. Simple design and rugged construction reduces maintenance



to a minimum. Installation is extremely simple. The engine is about 1/10th as heavy as diesel units of similar horsepower and occupies only 51 cu ft. No elaborate foundation or flooring base is required because the gas turbine is practically vibration-free.

Equipped with one of the several control systems available, the engine can be operated remotely and entirely automatically. It starts instantly and operates at full load without warmup, even after long periods of standby service.

Fuel economy of the Solar T-1000 engine is unmatched in its field. The engine runs equally well on a variety of fuels including gasoline, diesel fuel and natural gas. The exhaust may be used in a waste heat boiler or as combustion air in process apparatus or conventional boilers.

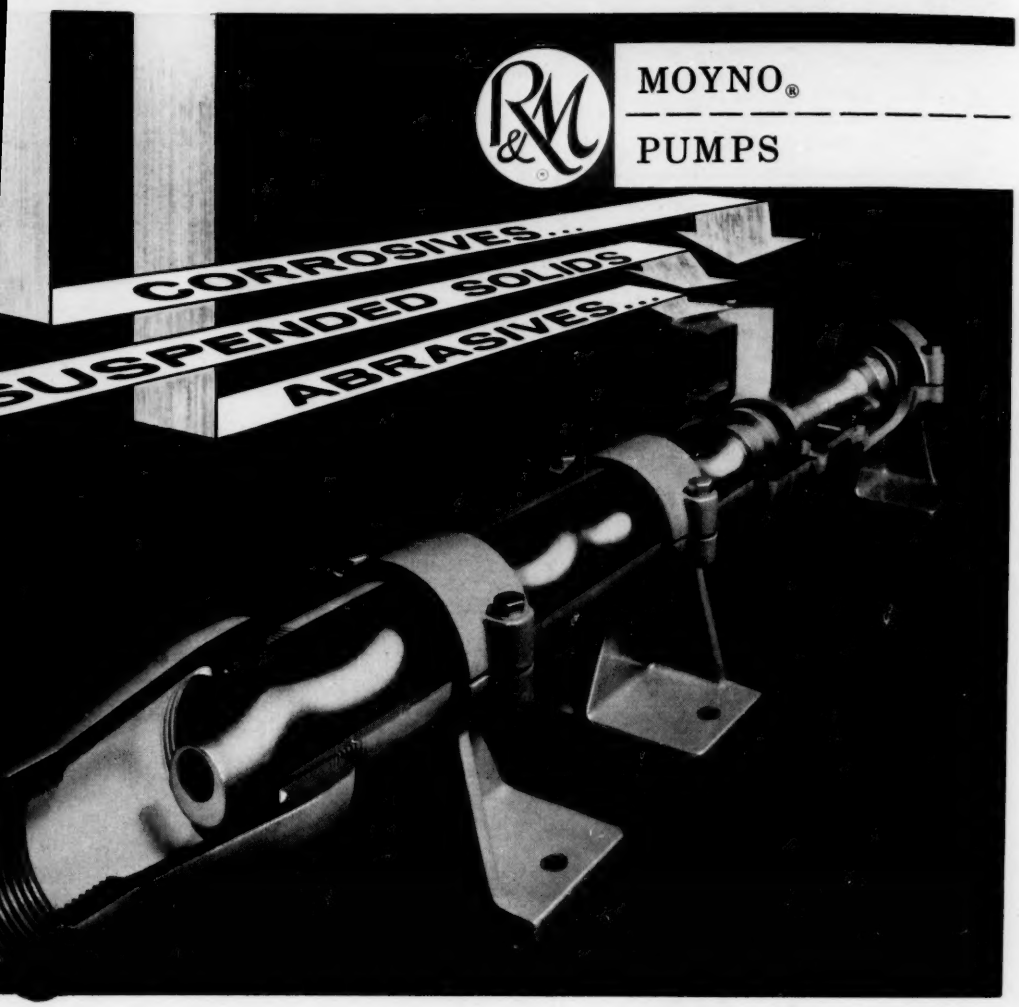
Cost of this gas turbine is competitive with diesel engines in many industrial applications. For further information on Solar's turbine-powered generator sets, its complete line of gas turbine engines or industrial compressors, write to Dept. **H-202**, Solar Aircraft Company, San Diego 12, California.

SOLAR

A subsidiary of International Harvester Company

MOYN

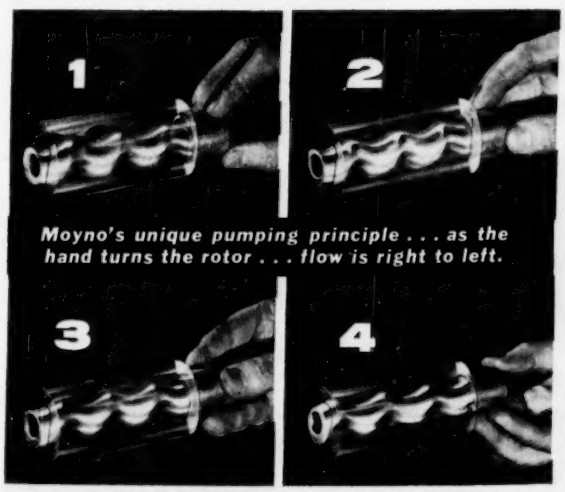
Moyno's
handle thin water
gnawing corrosive
dia.—without crush
contacts only one
volving in a double
or abrasives are t
made of special res
tenance and prolo
pumped by Moyno
able" . . . had run
on other type pum
Moyno pumps are
pressures to 1000
new Bulletin 100-



YNO® solves tough pumping problems!

o's "progressing cavities" successfully watery slurries, non-pourable abrasives, osives or suspended solids up to 1⅛" crushing, foaming or aerating! Material one moving part, a screw-like rotor re- louble-threaded stator. Where corrosives are to be handled, rotor and stator are al resistant materials that minimize main- prolong pump life. Many materials now Moyno were once considered "unpump- d run up prohibitive maintenance costs pumps or ruined them completely!

s are available in capacities to 500 gpm; 000 psi. Learn more . . . write today for 100-CE!



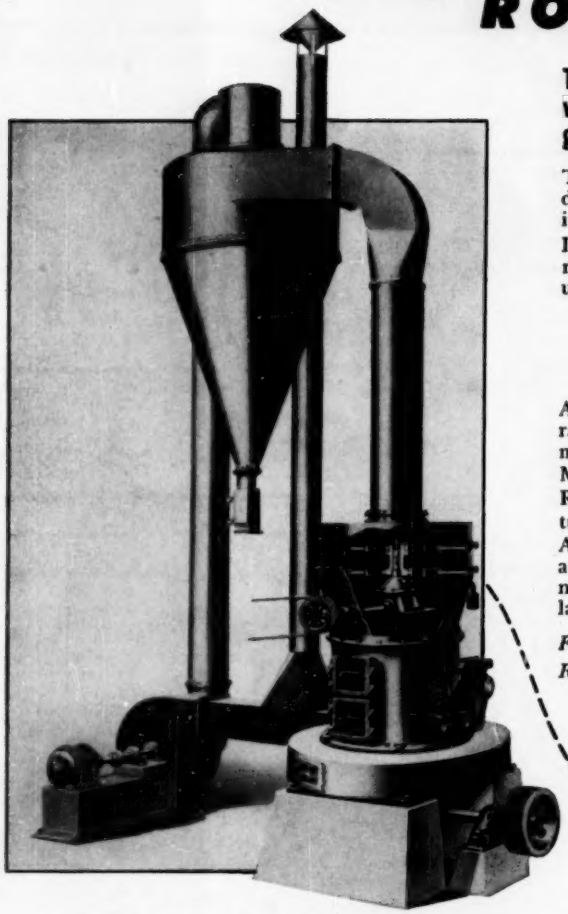
Moyno's unique pumping principle . . . as the hand turns the rotor . . . flow is right to left.

ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno® Industrial Pumps
Propellair® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

roll up new production... and profit...records

with **Raymond ROLLER MILLS**



RAYMOND MULTI-PURPOSE ROLLER MILL
WITH DOUBLE WHIZZER AIR SEPARATOR

Top performing RAYMOND Multi-Purpose ROLLER MILLS with WHIZZER AIR SEPARATION lead the field in fine grinding in the CHEMICAL and PROCESS INDUSTRIES.

This Mill combines the Raymond High Side Roller Mill and the double Whizzer Separator to afford great versatility and economy in the handling of many fine grinding problems.

Its wide scope of application covers the preparation of powdered materials . . . from simple fillers to fancy chemicals. Typical products pulverized include . . .

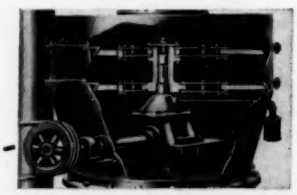
PIGMENTS • FULLERS EARTH • INSECTICIDES • IRON OXIDES • TALC • BARYTES • KAOLIN AND CLAYS • SULPHUR • CARBON MIXTURES • STARCH • LIMESTONE • BAUXITE • CALCIUM SILICATE •MINERAL FILLERS • PHOSPHATE ROCK • GYPSUM.

A single, easy adjustment of the Whizzer controls the fineness range from 20-mesh grades to products essentially all minus 325-mesh.

Mill capacities reach 40 tons per hour and more with a Super Roller Mill. Flash Drying Accessories may be installed when moisture removal is required.

All aspects of Fine Grinding are combined in a clean, dust-free, automatic system that is economical in operation and maintenance. Installations are flexible and readily adaptable to any plant layout.

For detailed information send for the Raymond Roller Mill Catalog Number 79C



Mills are available with Single or Double Whizzer Separators. Whizzers have set of radial blades attached to a disk that revolves on a vertical shaft in separating chamber. Variable speed drive insures finger-tip control of fineness.

COMBUSTION ENGINEERING, INC.
Raymond Division

427 W. RANDOLPH ST.
CHICAGO 6, ILLINOIS

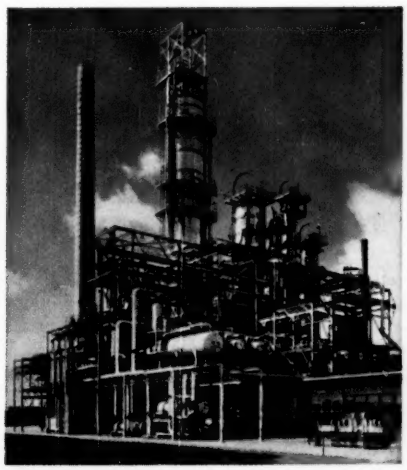
Sales Offices in Principal Cities

Combustion Engineering-Superheater Ltd., Montreal, Canada

POINT OF PRIDE

Stone & Webster engineers are justifiably proud of the successful process plants they have designed and constructed around the world. Each adds his full measure of skill and experience to the deep well of knowledge and ability that Stone & Webster can bring to your next process project.

We would welcome the opportunity to discuss how we might help you.



STONE & WEBSTER ENGINEERING CORPORATION

Affiliated with Stone & Webster Engineering Limited (London)

New York, 90 Broad Street — Boston, 49 Federal Street

Chicago · Houston · San Francisco · Los Angeles · Seattle · Toronto · Calgary

Now...proved in continuous operation...

simple, sure Continuous Freeness Recording by Bailey

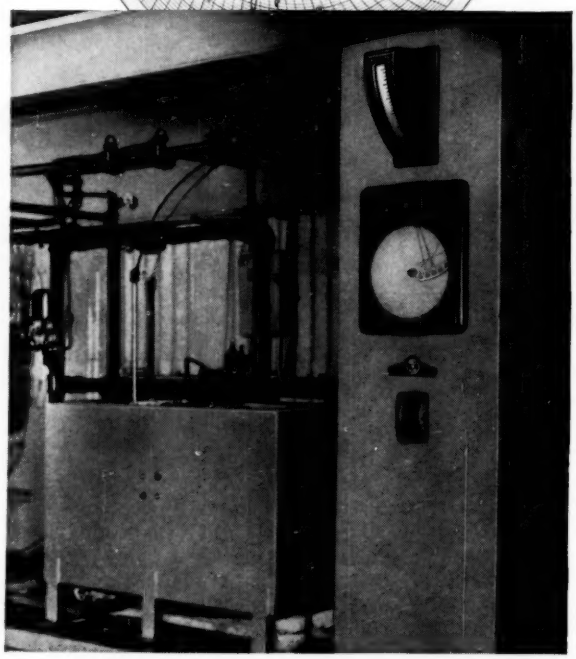
Dependable, *continuous* freeness recording has long been an objective of the pulp and paper industry.

Today it is a fact.

The Bailey Continuous Freeness Recorder, based on simple principles and utilizing equipment well-known by the pulp and paper industry, now provides a means for dependable, continuous measurement of freeness, proved in successful, continuing service for more than a year.

Its operation enables more accurate control of pulp stock characteristics...automatic control of refiners and jordans for sustained product quality. Performance is trouble-free . . . maintenance, negligible. Your Bailey Engineer will be glad to give you details. Call your nearest Bailey District Office, or write.

P151-1



Bailey Continuous Freeness Recorder in operation at a Southern newsprint plant.

PULP AND PAPER DIVISION

BAILEY METER COMPANY

1054 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada — Bailey Meter Company Limited, Montreal

BAILEY METERS

Make it LIGHT, make it STRONG...

Polyester Resins made with CARBIDE'S PROPYLENE GLYCOL

CARBIDE's commercial grades of propylene glycol are invaluable in polyester resin production—resulting in light, strong, weather-resistant, easy-to-mold, easy-to-color materials with many uses.

From resins in chairs to humectants for tobacco, the *consistent* high purity of CARBIDE's propylene glycol plays an important part in the sales appeal and performance of countless products.

Sturdy boat hulls, appliance parts, furniture, roofing, room dividers, fuel-oil tanks, foams, lubricants, paints, anti-freeze solutions, and aircraft parts exemplify the diversity of products to which propylene glycol is now making profitable and effective contributions.

CARBIDE's U.S.P. grade of propylene glycol is colorless, odorless, tasteless, and completely miscible in water. Its *low* toxicity makes it ideal for products that come in contact with the mucous membranes.

It is an excellent solvent with limitless applications in organic chemistry . . . a dependable humectant for packaged goods . . . a softening agent, spreader, and emollient . . . an aid in the sealing, coating, and safeguarding of foods and beverages.

For full information on any grade of propylene glycol—and 13 other diols and triols—call your CARBIDE Technical Representative, or write Union Carbide Chemicals Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y.

UNION CARBIDE is a registered trade mark.

UNION CARBIDE CHEMICALS COMPANY

UNION CARBIDE

BOILERS TO GO!

Delivered to the installation site by rail, truck or boat, shop-assembled Vogt Package Water Tube Boilers can be quickly placed in operation. After being placed from the carrier onto a simple low-cost concrete slab, a Vogt unit requires only piping, electrical and stack connections to go to work.

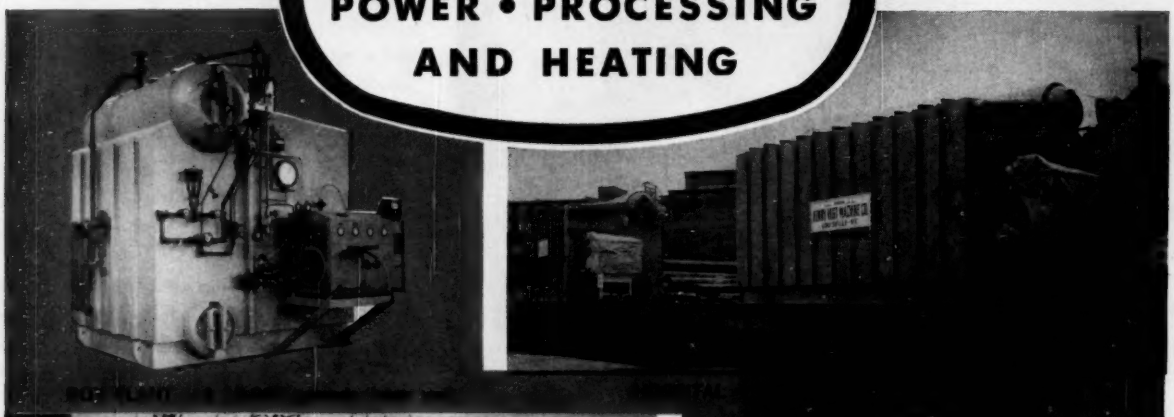
Little space is required because of their compact design and integrated firing equipment and controls.

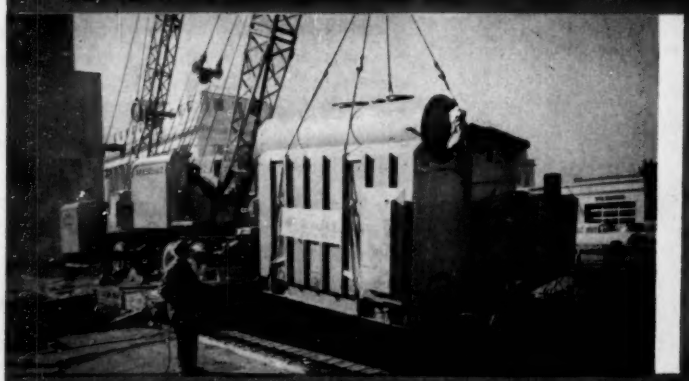
A pressure type steel casing permits outdoor operation, if desired, eliminating the need for an expensive building.

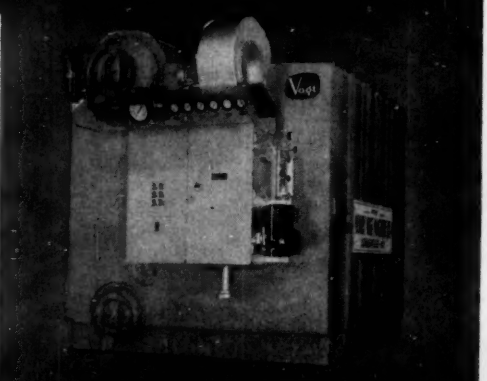
Write for literature. Address Dept. **24A-BC**

Vogt

PACKAGED BOILERS
Shop Assembled for
POWER • PROCESSING AND HEATING

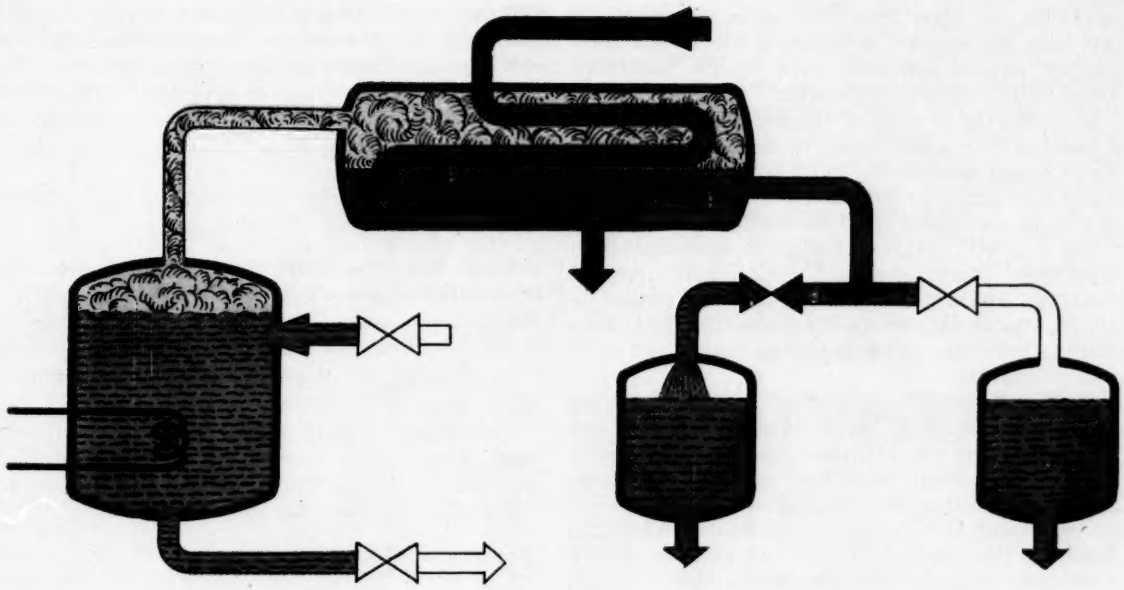






HENRY VOGT MACHINE CO.
Louisville, Kentucky

SALES OFFICES: Camden, N. J., Charleston, W. Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis.



Batch Distillation of Binary Mixtures Provides Versatile Process Operations

Batch stills are the most economical process units to handle mixture variations and small production runs that occur in industrial chemical operations.

BENJAMIN BLOCK, *Abbott Laboratories*

Batch distillation is a means for separating a mixture of liquids into integral quantities. By implication, a certain amount of a liquid mixture is initially charged to a vessel and the components are separated by heating the vessel to produce boiling, condensing the vapors and collecting the components according to their specific boiling points.

Over the years, considerable modification and improvement have been effected in batch distillation. In modern units, a rectifier or column is included to take advantage of differential condensation and reevaporation to improve purity. Auxiliary equipment has changed over the years and new methods of control have been devised. Yet, in this day of continuous handling and processing, the batch unit still plays a very important part in industrial chemical operations. What great attraction does this means of separation have that assures it this position?

Probably the most outstanding attribute is flexibility. Very little change is required when switching from one fluid mixture to another. Reflux rate and throughput can be varied easily without the need of balancing or adjusting several instruments. No balance of feed and drawoff need be maintained. In a situation where the composition of the feed may change frequently or where completely different mixtures must be handled from day to day, the versatility of the batch still is unexcelled.

The batch still is the most economical means of separating pure components from a multicomponent mixture. Using continuous separation, a separate still

This *Chemical Engineering* report on the design and use of batch stills for binary mixtures contains certain of the fundamental distillation relations that were reviewed in the CE Refresher in our Jan. 23, 1961 issue. However, these relations have been included here to provide an all-inclusive article.—ED.

would be required for each pure liquid (less one); batchwise, one merely needs to switch receivers. In this case, the decision of design would involve comparative economics because large volume production would likely justify multiple stills.

If we had the problem of designing a still to handle a material with a high solids content, or a substance that becomes very viscous on concentration, or a compound that has a serious scaling tendency, what type of continuous column could we specify? Bubble caps would clog with solids or scale; the same applies to sieve trays. A packed column would require frequent cleaning. And so, we would arrange the process to accept a batch still where the solids, the thick gunk and the scale stay in the pot to be flushed out or be easily removed.

Another great stronghold of batch distillation is the small production unit. Here the level of production justifies neither the additional equipment accessories nor the operational setup time required for a continuous installation. To a large extent, this point could be considered an extension of flexibility. Where the flexibility described above was for variation of mixture, this one is for variation of quantity.

Having definitely established the batch distillation unit in its appropriate place in the chemical industry, we can proceed with considerations of design, theoretical and practical.

Consider the Simple Still

A distillation unit of the type used by the alchemist is known as a simple still. Though comparatively few such stills are found in industrial use today, they have application in some instances where only a rough separation of components is required. In form, they involve a pot with provision for heating (steam coils or jacket or electric mantle), a condenser and receivers.

Rayleigh[1] developed an equation for simple batch distillation. Referring to the diagram on p. 87, the relationship can be developed as:

$$-y\,dV = d(Wx)$$

Since $dV = -dW$:

$$y\,dW = W\,dx + x\,dW$$

$$\frac{dW}{W} = \frac{dx}{y - x}$$

Integrating this equation gives:

$$\ln\left(\frac{W}{W_i}\right) = \int_{x_i}^{x_w} \frac{dx}{y - x} \qquad (1)$$

Use of Eq. (1) involves a graphical integration with the assumption that the vapor is in equilibrium with the liquid. Values of x are chosen, the corresponding equilibrium values of y taken from an equilibrium curve and values of $1/(y\text{-}x)$ are tabulated. The area under the curve of the graph of the tabulated values of $1/(y\text{-}x)$ against x would be $\ln W/W_i$ where W is the final pot content.

As an example, consider the distillation of an alcohol-water mixture. Material charged to the still is 36% by weight ethanol (18 mole %). The mixture must be reduced to a maximum ethanol concentration of 6 mole %. Values are tabulated:

x	y	$(y - x)$	$1/(y - x)$
0.180	0.517	0.337	2.97
0.160	0.502	0.342	2.91
0.140	0.485	0.345	2.90
0.120	0.464	0.344	2.90
0.100	0.438	0.338	2.97
0.080	0.405	0.325	3.08
0.060	0.353	0.293	3.41

Fig. 1 is a curve of the values shown in the table. Integrating graphically by Simpson's rule, we get:

$$\ln\frac{W}{W_i} = -\frac{0.02}{3}(53.68) = -0.358$$

Then, $\ln(W_i/W) = 0.358$ or $W_i/W = 1.43$. Solving for W gives $W = W_i/1.43$.

Considerable simplification will be obtained if some relationship can be found for y as a function of x. Occasionally the relative volatility α will be constant. For a binary mixture, the term α is defined as:

$$\alpha = \frac{y_A/x_A}{y_B/x_B} = \frac{y/x}{(1 - y)(1 - x)} = \frac{y(1 - x)}{x(1 - y)} \qquad (2)$$

Solving for y gives:

$$y = \frac{\alpha x}{1 + (\alpha - 1)x} \qquad (3)$$

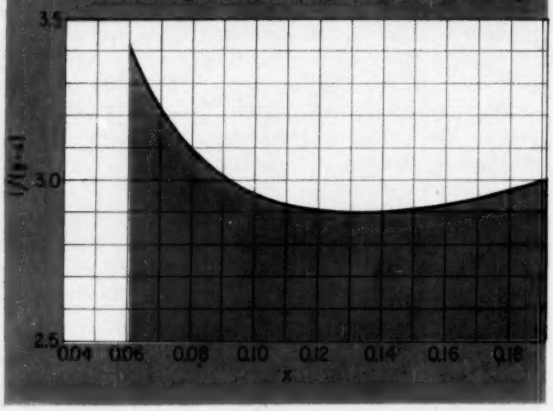
Inserting Eq. (3) for its equivalent in the integration provides a means for direct analytical solution.

$$\ln\left(\frac{W}{W_i}\right) = \int_{x_i}^{x_w} \frac{dx}{(y - x)}$$

$$= \int_{x_i}^{x_w} \frac{dx}{\left(\dfrac{\alpha x}{1 + (\alpha - 1)x}\right) - x}$$

$$= \frac{1}{\alpha - 1}\ln\left[\frac{x_w(1 - x_i)}{x_i(1 - x_w)}\right] + \ln\left[\frac{1 - x_i}{1 - x_w}\right]$$

Evaluate integral by Simpson's rule—Fig. 1



If the relative volatility is not constant, other relationships of y as $f(x)$ can often be worked out. The ease of graphical calculations required for simple still design would usually preclude very much of a search in this direction, although such a tool would be convenient in one of the following, more complex, calculations.

Column Design Considerations

Primarily, industrial design requirements call for separation of relatively pure components from a liquid mixture. Effecting this separation calls for a series of equipment items that would include a still pot, column (rectifier), condenser, subcooler and a set of receivers, usually two or more. In this sequence, probably the most critical item is the column. However, in order to start calculating, a basis for design must be established.

The first thing that must be developed is as thorough a set of physical information as possible. Vapor-liquid equilibria, vapor and liquid densities of the pure components (and mixtures, if possible), and boiling temperatures are essential. Viscosities, specific heats and heats of vaporization should be obtained whenever feasible. Accumulating an extensive file of data may take a little more time at the start, but it will save time during the course of design and reduce the number of assumed values.

Most engineering design is based, fundamentally, on sound principles that can be developed to a given point while adhering to a rigid derivation. The demand of practical limitations, however, requires the insertion of assumptions and approximations in order to arrive at a usable result. Each assumption and approximation that is used introduces a degree of unreliability into the final result. If a little additional literature search or laboratory study can replace an approximation with a fact, a closer approach to correct design can be attained.

Having a set of physical data, a goal must be set to serve as a basis for design. This design basis would include:

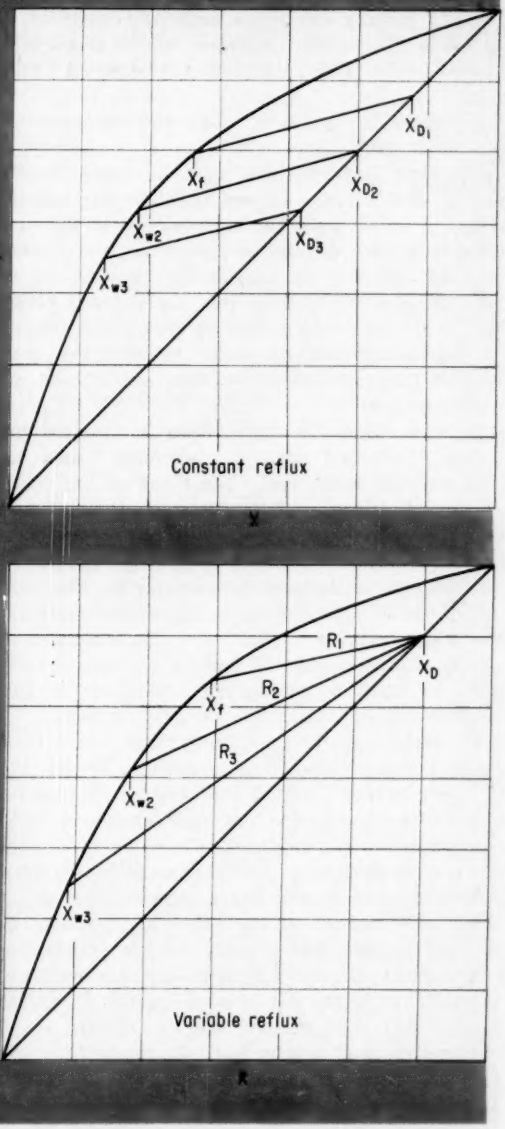
1. Composition of material charged to still.
2. Composition of distillate.
3. Composition of residue.
4. Design product rate.
5. Vaporization or boilup rate.

Items 1, 2 and 3 are usually set by process requirements. A batch still can accommodate a wide variation in feed composition but some particular value must be chosen for design purposes. The distillate is usually the desired product and its composition is set by product specification. Composition of the residue is usually set as low as practicable to avoid loss of product and to keep the biochemical oxygen demand on the sewage treatment plant to a minimum. The requirement of distillate and residue are, of course, interrelated so that one of these must be chosen as a primary specification.

On the other hand, Items 4 and 5 have some flexibility and can frequently be adjusted to produce an economical design. In fact, they are interdependent being related by the reflux ratio. Perhaps, the best means for setting the values of these would be to choose a design product rate, assume a nominal reflux rate and calculate the total vapor loading that would be required. If further calculation indicates that too large a column would be necessary to handle this vapor load, or that a different reflux rate is advantageous, adjustment of these items can be made.

Physical data have been collected and design basis established. We now want to get into design of the

Select method to operate column—Fig. 2



column. The basic principle of the rectifying column is enrichment by differential condensation and evaporation.

As the vapor rises from Plate 1 to Plate 2, it contacts liquid that is flowing downward. If the liquid and vapor are intimately contacted, a heat interchange occurs. The fraction of the vapor that is higher boiling condenses in favor of the evaporation of that portion of the liquid that is most volatile. The vapor rising from the plate contains a higher percentage of the lower boiling component, having been enriched by this interchange. Determination of the relative quantities of liquid and vapor, the number of plates and the means of assuring good contact constitute the essentials of distillation column design.

The design methods presented here incorporate the "usual simplifying assumptions." These are:

1. Equimolal overflow. The mole quantity of a fluid passing one section of the column is the same as the quantity passing any other section. Inherently, then, one mole of condensing vapor would evaporate one mole of liquid. This relationship is based on Trouton's rule.

2. Adiabatic operation. Column heat losses are assumed negligible.

The first decision that must be made is how to operate the column. Do we maintain the reflux constant, in which case the composition of the product changes as the distillation proceeds; or maintain a constant product composition by varying the reflux rate. Illustration of these two alternates is presented in Fig. 2. To avoid cluttering this drawing, assume an infinite number of plates so that the pot and product compositions are at the extremities of the operating line.

In both cases, the composition in the pot changes as the distillation proceeds, becoming leaner in the more volatile component. The slope of the operating line is the internal reflux ratio L/V. In the top drawing of Fig. 2, reflux ratio is maintained at a constant level. As the composition of the pot changes, the product composition alters accordingly. The composition of the total product is the summation of the increments of collected product. In the bottom drawing of Fig. 2, the product is held to a constant composition. In order to accomplish this result as the pot becomes leaner, the reflux ratio is increased.

In designing, then, we must look for a basis of choice between these two alternatives. If the quantity of lower-boiling fraction that can be extracted from a given feed composition is considered as a criterion, the limitation for constant reflux is the specification of the over-all product composition, although the specific reflux ratio chosen has a tempering effect.

Variable reflux, on the other hand, would be restricted in this respect only by the practical upper reflux ratio. Realistically speaking, however, remaining product in the pot after minimum product specification has been reached can be collected in a tails cut and so need not be lost. As might be suspected, the choice between constant or variable reflux is a matter of the characteristics of the specific system, the demands of the process with regard to controls and instrumentation and the study of other facts available to the process engineer.

A comparison of constant and variable reflux for several systems is presented in Fig. 3. The benzene-toluene system was chosen because of its reputation as an ideal mixture; ethanol-water, isopropanol-water and acetone-water were chosen because of their general interest.

These graphs show the relationship of distillation rate to the number of theoretical plates for variable reflux and for a particular value of constant reflux. They are calculated on the basis of the same distillate and bottoms composition for both cases. The derivation of these curves will be given later.

At this time, it is important to us to extract the following information: in a column of few theoretical plates, a constant reflux ratio is advantageous; when the number of theoretical plates becomes large, variable reflux will be the operation of choice. There exists a region where the ease of control or other criteria may determine the type of operation. This region depends on the system, the reflux ratios under consideration and the operating limits imposed.

The reflux ratios and composition limits chosen for the graphs were selected largely on the appearance of the equilibrium curve and are not necessarily ideal. They are based on the ability to include a sufficient number of theoretical plates without getting into a pinch area that would incorporate inaccuracies and reduce the effectiveness of the study.

Speaking very generally, in a column having less than five theoretical plates, constant reflux is likely to have the upper edge. For the area between five and ten plates, we note on the one hand that constant reflux is more adaptable to manual control and that on the other hand that variable reflux will generally extract the maximum product.

Automatic control of variable reflux depends on sufficient change in a physical property with a change in product concentration to actuate the controller, while constant reflux would employ a simple ratio controller. The constant-reflux distillation system must incorporate a distinct cut-off point to avoid running too much higher-boiling component into the product and missing the specification. The variable reflux product is maintained at the desired composition throughout the distillation.

The design engineer must take all these factors into account as well as the instrumentation cost that the installation will justify and the physical properties of the system in making his selection.

Example Illustrates Methods

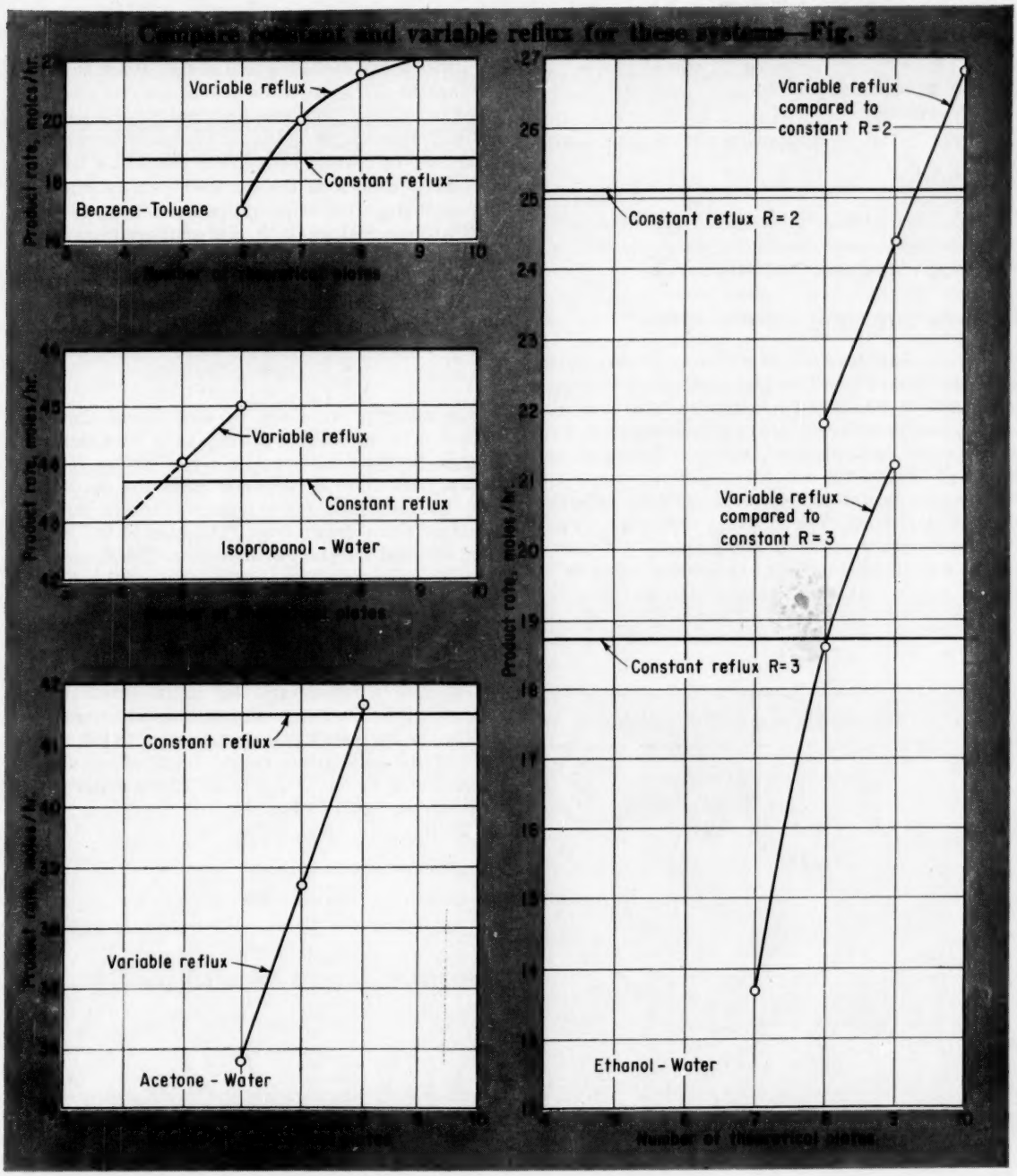
As the phases of batch distillation design are discussed, let's look at the calculations for a typical system. Perhaps the most common liquid mixture separated by distillation is ethanol and water. Although this mixture is not ideal, technically speaking, this deviation itself recommends the system for our study.

Initial stage of the design involves compilation of physical data and formulation of a basis for design. Let us assume that we have a complete set of physical data on ethanol-water mixtures and have compiled this information into a convenient form for use. In setting the basis for design, list the items as previously outlined:

1. Composition of material charged to still. Take this at 36% by weight ethanol, and assume a charge of 12,000 lb. (1,525 gal.).

2. Composition of distillate to be 91.2% ethanol.

3. Composition of residue. For this distillation, composition is not definitely set. It will suit the purposes of this example best to leave this item open to variation. We might note, however, that after the product is removed, the pot residue will be further



reduced by taking a tails cut. The residue that remains will be sewered.

4. Design product rate. The product rate is tied to the vaporization rate by the reflux ratio. It is to our advantage at this point to set the vaporization rate and let the product rate tag along.

5. Vaporization rate. Assume this at 75 moles/hr.

At this point, we might tabulate the significant items:

a. Feed:

	Weight, %	Weight, Lb.	Moles	Mole-Fraction
C_2H_5OH	36.0	4,320	94	0.180
H_2O	64.0	7,860	426	0.820
		12,000	520*	

* Average molecular weight is 23.

b. Product:

	Weight, %	Mole-Fraction
C_2H_5OH	91.2	0.800
H_2O	8.8	0.200

c. Sludge: Deferred.

d. Product rate: Deferred.

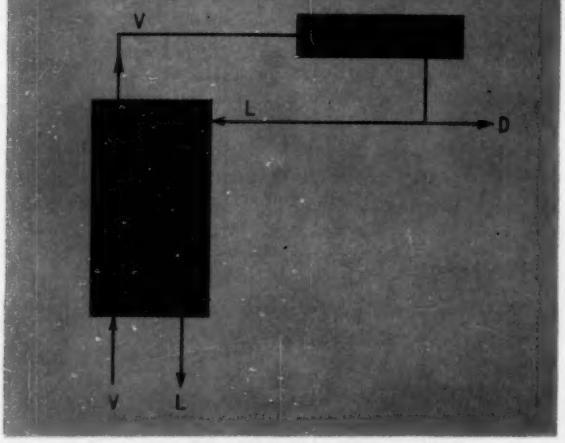
e. Vaporization rate: 75 moles/hr.

Distillation Occurs at Constant Reflux

The approach to constant reflux involves a choice of reflux ratio. Since this factor affects the diameter and height of the column as well as the size of heating and cooling auxiliaries, the ultimate decision rests with an economic balance between first cost and operating costs.

For the calculations, there must be a reference point to start from. The condition of minimum reflux represents such a point. In the graphical representation of a distillation process, the internal reflux ration L/V is represented by the slope of the operating line.

Material balance gives reflux ratio—Fig. 4



The relationship of the internal reflux to the reflux ratio ($R = L/D$) can be determined by referring to Fig. 4.

$$V = L + D$$

$$\frac{V}{L} = \frac{L}{L} + \frac{D}{L} = 1 + \frac{1}{R} = \frac{R+1}{R}$$

Hence:

$$\frac{L}{V} = \frac{R}{(R+1)} \tag{4}$$

Similarly, working in the other direction:

$$R = \frac{L/V}{1-(L/V)} \tag{5}$$

In Fig. 5, the operating line is DF. Point D, representing the distillate, is on the diagonal since $x_D = y_D$. The Point F represents the condition in the still pot with coordinates (x_i, y_i). Minimum reflux for a binary mixture whose equilibrium curve does not have an inflection, such as the system shown in Fig. 5, is represented by the slope of the line DF joining the distillate composition with the equilibrium condition of the pot mixture. Stepping off plates from Point D would lead to an infinite condition as we approach F. Hence, there will be an infinite number of plates. Then the minimum reflux can be calculated from:

$$\left(\frac{L}{V}\right)_m = \frac{\Delta y}{\Delta x} = \frac{(y_D - y_i)}{(x_D - x_i)} \tag{6}$$

Frequently a curve will be encountered that does have a point of inflection, such as is also shown in Fig. 5. If the operating line for minimum reflux is drawn from D to F, it would cross the equilibrium line. The condition for minimum reflux in this case would be a line drawn from D tangent to the equilibrium curve at the point of inflection. The slope of the line DP represents the minimum internal reflux, so that:

$$\left(\frac{L}{V}\right)_m = \frac{(y_D - y_p)}{(x_D - x_p)} \tag{7}$$

Choice of a reflux ratio for initial calculations is determined by the minimum reflux as calculated above and by the engineer's judgment relating to the appearance of the equilibrium curve. Basis of calculations is usually a factor of 1.5 to 10 times minimum.

Referring again to Fig. 4:

$$dD = -dW$$

By component balance:

$$x_D\, dD = d(Wx_w)$$

Substituting for dD and differentiating gives:

$$-x_d\, dW = W\, dx_w + x_w\, dW$$

Separating variables and integrating yields:

$$-\frac{dW}{W} = \frac{dx_w}{x_D - x_w}$$

$$\ln \frac{W_i}{W} = \int_{x_i}^{x_w} \frac{dx_w}{x_D - x_w} \tag{8}$$

Calculating W from Eq. (8), an over-all component balance gives the average distillate composition:

$$W_i x_i - W x_w = D x_{Dav} = (W_i - W) x_{Dav}$$

$$x_{Dav} = \frac{(W_i x_i - W x_w)}{W_i - W} \tag{9}$$

Solution of the distillation problem will require a trial-and-error calculation until the W found from Eq. (8) provides an x_{Dav} in Eq. (9) that matches the specification.

By material balance $V = L + D$. Since, $R = L/D$:

$$\frac{V}{D} = \frac{L}{D} + 1 = R + 1$$

$$D = \frac{V}{(R+1)} \tag{10}$$

If Eq. (11) expressed D and V in terms of moles/hr., then:

$$W = W_i - D\theta = W_i - \frac{V\theta}{(R+1)} \tag{11}$$

Call the following integral Q:

$$\int_{x_i}^{x_w} \frac{dx_w}{x_D - x_w} = Q$$

Then, from Eqs. (8) and (11),

$$\frac{W_i}{W_i - \dfrac{V\theta}{(R+1)}} = e^Q$$

$$\theta = (R+1)\frac{W_i}{V}\left(\frac{e^Q - 1}{e^Q}\right) \tag{12}$$

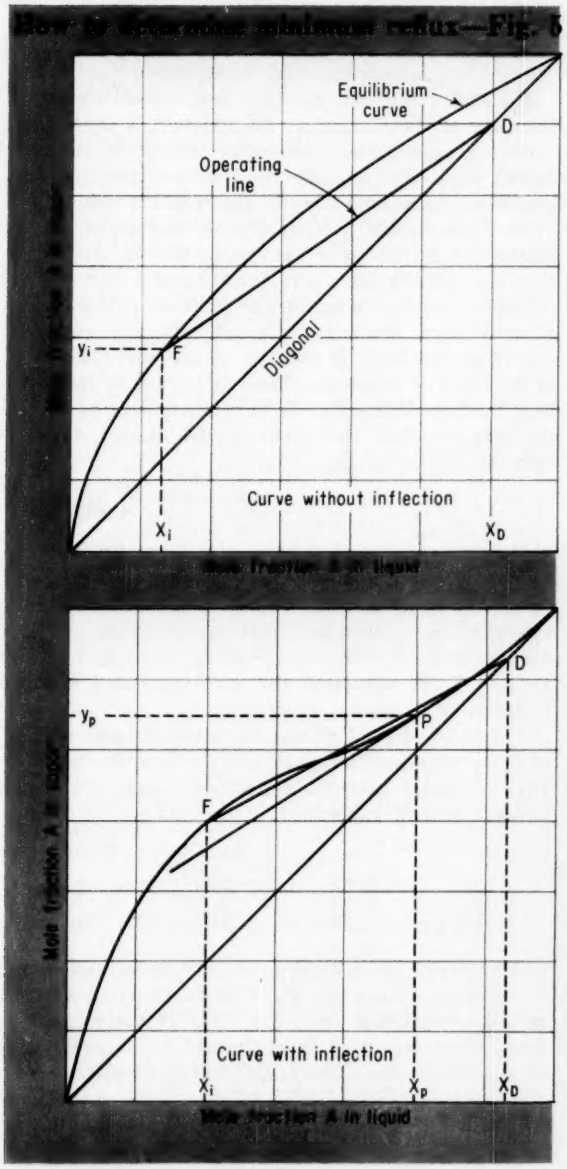
The factor Q has already been evaluated in Eq. (8), so solution of Eq. (12) presents no difficulty.

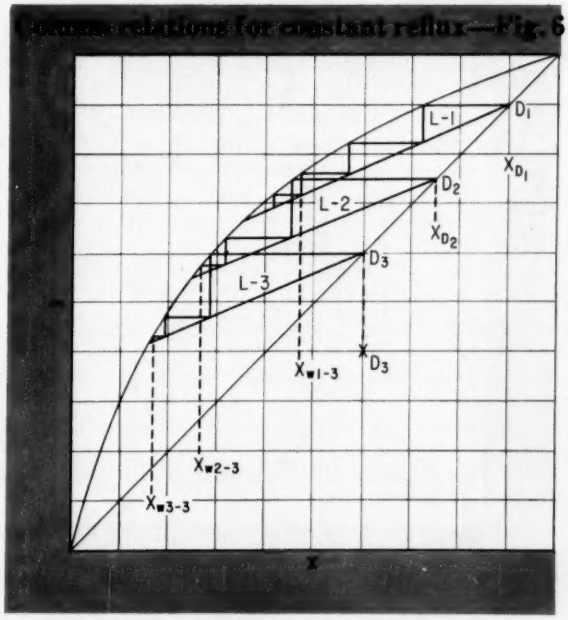
As a check on the integration:

$$\theta = \frac{W_i - W}{D} = \frac{R+1}{V}(W_i - W) \tag{13}$$

The equilibrium diagram Fig. 6 is used for the calculations. Operating lines are drawn passing through the diagonal and equilibrium curve with a slope L/V according to the internal reflux ratio that has been selected. Spacing of these lines in Fig. 6 has been exaggerated for clarity.

Using each operating line, theoretical plates are stepped off starting at the intersection with the diagonal, which is the distillate composition. Considering the operating line L-1, x_{w1-1} would be the bottoms composition for a one-theoretical plate column that was being operated at the reflux ratio L/V and producing distillate of composition x_{D1}. A column hav-





ing two theoretical plates could produce the same distillate composition when the bottoms composition was x_{w1-2} and so on.

To follow through the calculations, take a three-plate column as an example. On operating line L-1, distillate composition is x_{D1} and the bottoms would be x_{w1-2}; on L-2, distillate is x_{D2} and bottoms x_{w2-3}. A tabulation is made of x_D, x_w, (x_D-x_w) and $1/(x_D-x_w)$. From this table, points are obtained for a graph of $1/(x_D-x_w)$ vs. x_w as shown in Fig. 7. Graphical integration with limits x_i and x_w is used for Eq. (8) to obtain $\ln(W_i/W)$ and subsequently W.

Then, Eq. (9) is used to determine the average composition of the distillate. The procedure is progressive: an x_w is selected; through the above procedure, x_{Dav} is calculated. If the calculated value is above the specification, a lower x_w is chosen and the incremental area of integration is added to the integral of the previous calculation.

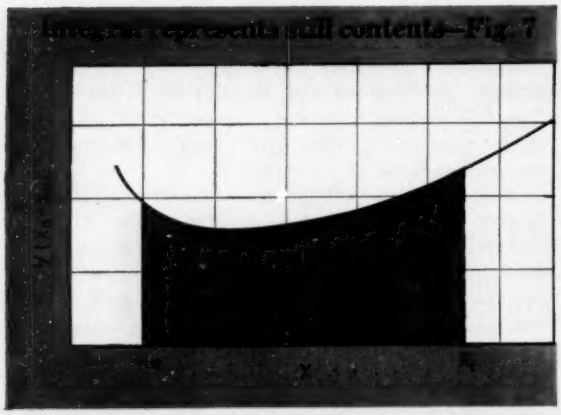
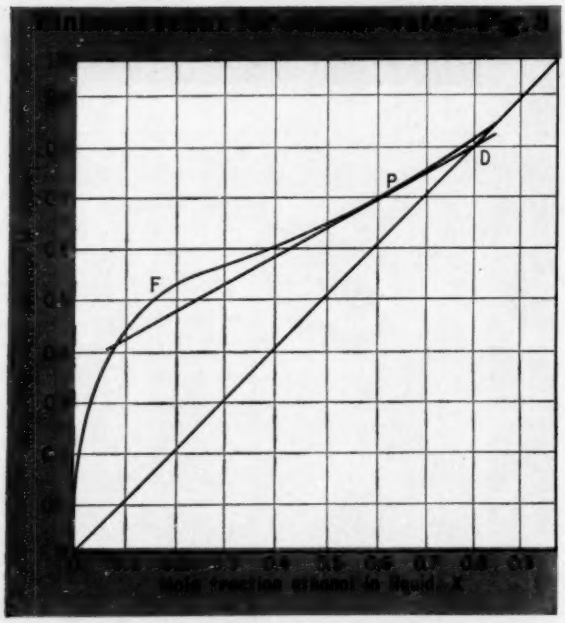


Fig. 7



Since we are in the process of designing a column for optimum conditions, our investigation should consider several theoretical plate possibilities. We would also want to check several reflux ratios. In addition, it should be kept in mind that the pot itself represents one theoretical plate.

The term Q in Eq. (12) has already been computed as a part of the foregoing procedure. Hence, it is a simple matter to calculate θ, the time of distillation. It must be kept in mind at this point that the θ found by Eq. (12) is only the actual separation time and does not include the time for loading the pot, heating and stabilizing the column, front and tail cuts and shutting down. The cost of sizing a column to attain a distillation time of 1 hr. would be foolishly spent if the preparation and cleanup time amounted to 3 or 4 hr.

For each reflux ratio, a curve can be drawn relating the time of distillation to the number of theoretical plates. For purposes of economic evaluation, it would benefit the design engineer to draw a curve that also includes turn-around time in the ordinate values.

To illustrate the procedure described above, let us continue the illustrative example. We see in Fig. 8 that the equilibrium curve for ethanol-water has an inflection and that a line drawn between points D and F would cross the curve. To get minimum reflux, a line is drawn from D tangent to the curve where P is the point of tangency. The exact point of tangency is difficult to determine. So it is convenient to extend the line and use the point (0.600, 0.695) for the calculation. Using Eq. (7):

$$\left(\frac{L}{V}\right)_m = \frac{y_D - y_P}{x_D - x_P} = \frac{0.800 - 0.695}{0.800 - 0.600} = 0.52$$

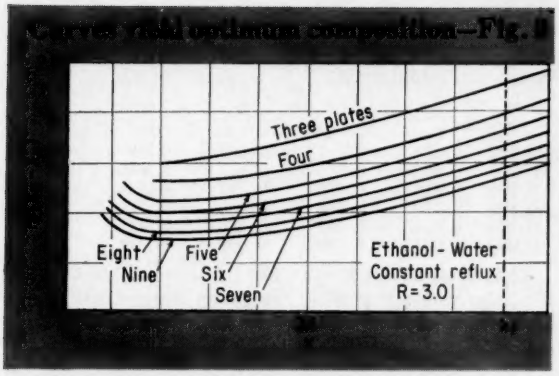
For the first series of calculations, let's choose $L/V = 0.75$. A plot of the equilibrium curve with operating lines of slope 0.75 is drawn for assumed values of x_D. Theoretical plates are drawn for each operating line. The values of x_D, x_w, (x_D-x_w) and $1/(x_D-x_w)$ are tabulated for each plate and a curve is drawn of $1/(x_D-x_w)$ against x_w.

A system of such curves for ethanol-water at L/V of 0.75, which corresponds to $R = 3.0$, is shown in Fig. 9. Values used for the seventh plate are shown in the following table:

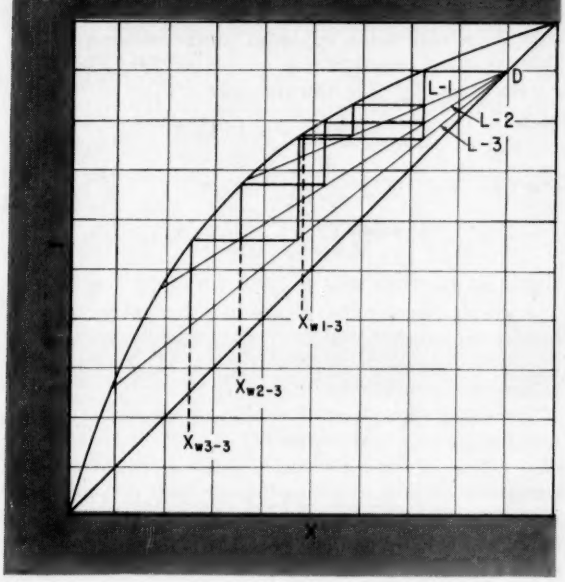
x_D	x_w	$x_D - x_w$	$1/(x_D - x_w)$
0.800	0.323	0.478	2.09
0.775	0.041	0.734	1.36
0.750	0.026	0.724	1.38

An integration is then made between x_i and a trial value of x_w. The ratio W_i/W is found from Eq. (8) and x_{Dav} calculated from Eq. (9). If the x_{Dav} is too high, the integration is performed to a lower value of x_w. Final values obtained for seven plates were:

x_w	0.04
$\ln(W_i/W)$	0.205
W_i/W	1.228
W	424 moles



Curves yield optimum composition—Fig. 9



Column helps vlor for variable reflux—Fig. 10

$$x_{D_{av}} = \frac{(520)(180) - (424)(0.02)}{(520 - 424)} = 0.799$$

Then from Eq. (12), we find the time required for the distillation:

$$\theta = \frac{(4)(520)(e^{0.205} - 1)}{(75)(e^{0.205})} = 5.2 \text{ hr.}$$

For distillation rate, calculate as follows:

$$D = \frac{520 - 424}{5.2} = 18.5 \text{ moles/hr.}$$

Calculating θ and D by Eq. (13) provides a numerical check.

Note that since the rate of distillate takeoff D is constant, a change in the time of distillation reflects a change in the quantity of material reclaimed as product. For ethanol at $R = 3.0$, this relationship for $x_{D_{av}} = 0.800$ is as follows:

Plates	x_w	$W_i - W$ Moles	θ Hr.	D Moles/Hr.
7	0.04	96	5.2	18.5
8	0.02	106	5.6	18.9
9	0.01	109	5.8	18.8
				18.7 avg.

A column of six plates or less will not make the required separation while equipment costs for more than eight or nine plates might not pay off. At nine plates, for instance, the small amount of ethanol remaining in the pot can be stripped off as a tails cut.

Constant reflux offers the primary advantage of ease of control. A manual installation would involve holding a predetermined ratio in the reading of two rotameters. Automatically, this function could be handled by a ratio controller or by a timed-deflection of the condensate using a solenoid-operated reflux splitter and a timer.

The difficult part of constant reflux control lies in the choice of the terminal point. A specific physical value must be found that relates to the condition where the total distillate contains the maximum percentage of the higher boiling component. This is the point where $x_{D_{av}}$ is at specification.

Column Operates With Variable Reflux

In the operation of a batch column under variable reflux conditions, the quantity of reflux returned to the column is adjusted to maintain a set distillate composition. At the start of a distillation, the pot is rich in the more volatile component and a low reflux ratio will produce the desired distillate. As the distillation proceeds, the reflux ratio must be continuously increased until a practical maximum is reached. At this time, the receivers would be switched, reflux reduced and a tails cut taken for reclaiming later.

Essential to variable reflux calculation is the choice of both distillate composition and final bottoms composition, although the latter item need not be chosen until part of the calculation has been done.

For variable reflux, the development of a working equation was done by Bogart.[3]

By material balance, $D = V - L$. Also, $dD = dW$.

$$dD = \left(1 - \frac{L}{V}\right) dV = -dW \qquad (14)$$

By component balance:

$$W = \frac{W_i(x_i - x_D)}{(x_w - x_D)}$$

Differentiating and rearranging gives:

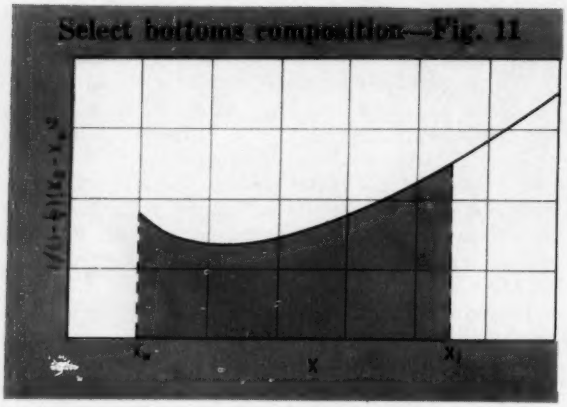
$$-dW = \frac{W_i(x_D - x_i)\,dx}{(x_D - x_w)^2} \qquad (15)$$

Substituting Eq. (14) into Eq. (15), we get:

$$\left(1 - \frac{L}{V}\right) dV = \frac{W_i(x_D - x_i)\,dx}{(x_D - x_w)^2}$$

Then, total quantity of vapor is:

$$\overline{V} = W_i(x_D - x_i) \int_{x_i}^{x_w} \frac{dx}{(x_D - x_w)^2} \qquad (16)$$



Since $\overline{V} = V\theta$, we can substitute in Eq. (16) to get:

$$\theta = \frac{W_i(x_D - x_i)}{V} \int_{x_i}^{x_w} \frac{dx}{(x_D - x_w)^2} \quad (17)$$

By material balance, we find:

$$W_i - W = \frac{W_i(x_i - x_w)}{(x_D - x_w)} \quad (18)$$

For the calculations for variable reflux, the equilibrium diagram of Fig. 10 is used. Operating lines are drawn with different slopes but all pass through the distillate composition (x_D, y_D), which is maintained constant throughout the distillation. As the distillation proceeds and the bottoms become leaner, the internal reflux L/V must be increased.

For example, consider the calculation for a 3-plate column, $x_{w1\text{-}2}$ would be the bottoms composition on L-1 at $(L/V)_1$; $x_{w2\text{-}3}$ would apply to L-2 at $(L/V)_2$; and so on. Tabulation in this case would be: L/V, x_w, $(x_D - x_w)$, $(x_D - x_w)^2$, $[1 - (L/V)]$, $[1 - (L/V)]$ $[x_D - x_w]^2$ and $1/[1 - (L/V)]$ $[x_D - x_w]^2$. A plot of this last term vs. x is made as shown in Fig. 11 and integrated between the limits x_i and x_w.

If picking the value of x_w has been deferred as mentioned earlier, inspection of our curve will frequently present a logical choice. Once the value of the integral is established, the value of θ can be calculated by Eq. (17) and the corresponding moles of product by Eq. (18).

At some future time, the question of the initial and final reflux ratios will arise. This information can be obtained from the curve of Fig. 11, although an additional plot of L/V in relation to x_w would be preferable. The initial internal reflux would be the L/V corresponding to x_i and the final value would be determined by x_w.

A comprehensive investigation would repeat the calculation for variable reflux in columns containing other theoretical plate values. Again, time for distillation as calculated above does not include allowance for loading, heating, discharging and cleaning.

For illustration of the method, let's look into the ethanol-water mixture discussed earlier. As in the previous example, consider a seven-plate column but this time operating with varying reflux. Values obtained for seven plates and $x_D = 0.800$ are tabulated in the table following:

A L/V	B x_w	C $x_D - x_w$	D $(x_D - x_w)^2$	E $1 - (L/V)$	F $1/ED$
0.600	0.654	0.147	0.022	0.400	115.7
0.700	0.453	0.348	0.121	0.300	27.5
0.750	0.318	0.483	0.233	0.250	17.2
0.800	0.143	0.658	0.433	0.200	11.5
0.850	0.054	0.747	0.558	0.150	11.9
0.900	0.021	0.780	0.608	0.100	16.4

The values of $1/[1 - (L/V)]$ $[x_D - x_w]^2$ in Column F of the preceding table for seven theoretical plates are plotted against x_w as shown in Fig. 12 along with values determined at other theoretical plate levels.

Integration of our curve requires a value for x_w that we have not set. According to the curve, a value as low as 0.02 or 0.01 could be conveniently worked out. However, it suits the purposes of this study to use 0.04 since this value appeared in the constant-reflux calculation at seven plates and $R = 3.0$. Then, we obtain from Eq. (17) the time as:

$$\theta = \frac{520(0.800 - 0.180)1.615}{75} = 7.0 \text{ hr.}$$

and from Eq. (18):

$$W_i - W = \frac{520(0.180 - 0.040)}{(0.800 - 0.040)} = 96 \text{ moles}$$

Hence, distillate rate D is 96/7.0 or 13.7 moles/hr.

A graph showing the change in reflux ratio required to maintain the desired product composition is shown in Fig. 13. Information for this curve is taken from values used to plot Fig. 12.

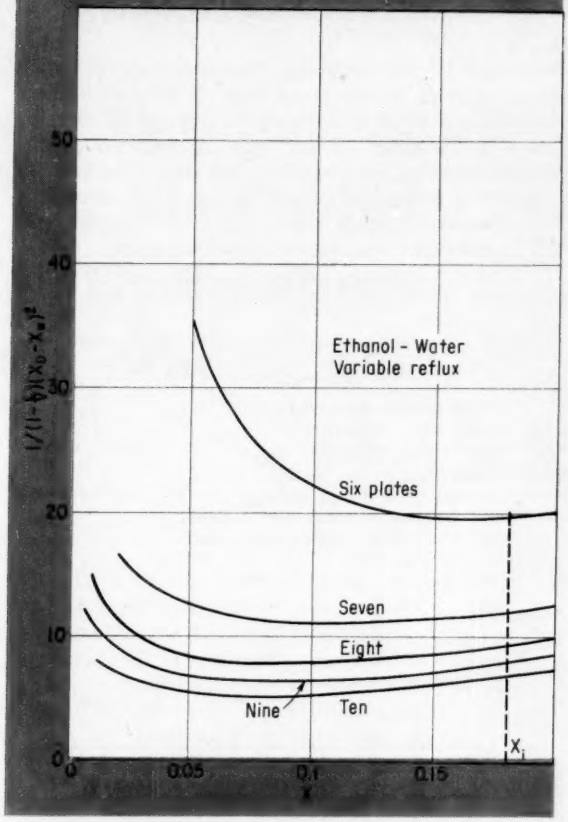
The calculations described above produced information for the curves shown in Fig. 3. Note that the variable reflux curve for ethanol-water is not the same comparing with $R = 2.0$ as the one used in comparing with $R = 3.0$. The difference lies in choosing the variables x_w in each case to match that obtained with the same number of plates at the constant reflux ratio used for comparison. A tabulation of the values for variable reflux of ethanol-water for comparison with $R = 3.0$ is given in the following table:

Plates	x_w	θ Hr.	$W_i - W$ Moles	D/θ Moles/Hr.
6	0.14	3.0	28	9.3
7	0.04	7.0	96	13.7
8	0.02	5.8	107	18.6
9	0.01	5.3	112	21.2

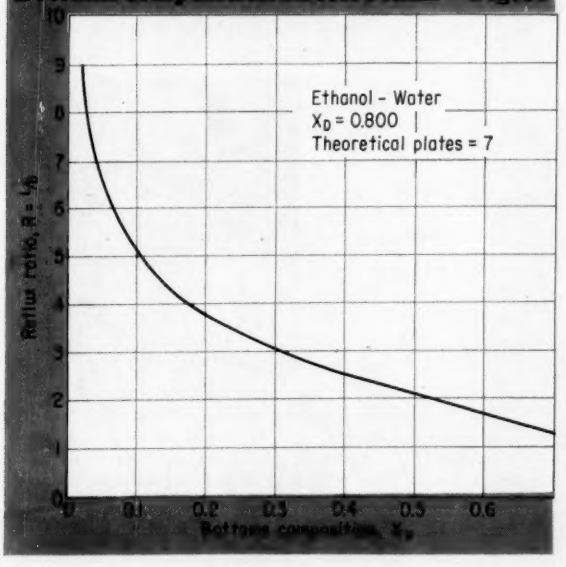
As the illustrations in Fig. 3 indicate, the value of variable reflux is related to the number of theoretical plates in the column. When the theoretical-plate count becomes relatively high, variable reflux operation provides a higher average distillate takeoff rate than does constant reflux.

However, control of reflux ratio must be tied to some variable that undergoes a sufficiently large change in value, when the composition of the overhead product changes, to actuate corrective control. Manual operation of true variable reflux would be questionable, but

Compare theoretical plate levels—Fig. 12



Bottoms composition affects reflux—Fig. 13



manual control of a unit by changing reflux ratio at prescribed intervals is a frequent practice.

Intermittent Total Reflux

A procedure that has gained some popularity is the use of intermittent total reflux. The column is operated at total reflux for a period of time long enough to stabilize its operation. It is switched to total drawoff (zero reflux) for a short time, after which operation at total reflux is resumed. This intermittent procedure can frequently produce the required product in a shorter time span than either constant or variable reflux. Control can be manual or a long span timer-solenoid switch combination will provide automatic control.

The control point for the change from reflux to product and back again must be some variable that changes significantly with concentration in the range which must be maintained for the distillate composition. Temperature of the vapor leaving the column is usually used. The difficulty in finding a suitable variable is frequently a decisive negative factor.

Distillation Columns for Batch Use

Recall that the purpose of the rectifying column is to provide an enrichment of the vapor by heat or enthalpy interchange, and to condense the higher-boiling portion of the vapor while evaporating the more volatile fraction of the liquid. The design of the column is based on providing for this interchange.

The variety of designs suitable for batch columns includes all of the constructions that are used for continuous units. The possibilities encompass plate types, generally described as fixed plates with provision for blowing vapor through the liquid flowing across the plate, as well as packed types in which vertical cylinders filled with shaped packing provide a locus of interfacial area for vapor-liquid contact. A general tabulation of some of the possibilities would be:

Plates

1. Bubble-cap.
2. Sieve trays.
3. Ballast.
4. Other types such as ripple and tunnel trays.

Packings

1. Raschig rings.
2. Saddles.
3. Pall rings.
4. Partition rings.
5. Tellerettes.
6. Other types such as those having spiral or woven packings.

In the choice of column construction, of first importance is the purpose of the installation. It will be recalled that four advantages were mentioned for batch distillation: (a) flexibility of product, (b) separation of components from a mixture of several, (c) flexibility of quantity and (d) reduced fouling and scale.

A column may be designed with more than one of these objectives in mind, but the limitations imposed

To order reprints of this 12-page report on Batch Distillation of Binary Mixtures, circle reprint number 174 on Reader Service card in this or any issue. Price 50¢ per copy.

by the chosen objectives must be kept in sight. The most restrictive items are (a) and (c). Flexibility of product requires that the distillation system must be able to accommodate a range of relative volatilities, vapor and liquid densities, boiling points and heats of vaporization. For flexibility of quantity, the unit must permit a large turn-down ratio; that is the relative rates at which the system will operate effectively.

It is considered desirable to operate a batch column at the maximum rate. The maximum rate for one liquid, however, may differ vastly from permissible values for a second. There is an additional restriction built into a distillation unit operated with variable reflux since the liquid loading is changed continuously.

Speaking in general terms, plate columns are more flexible than packed units and also cost more. A significant exception to this statement is the sieve plate, which is no more flexible than a packed unit and is designed for low cost. In the other direction, it is conceivable, though unlikely, that a packed unit utilizing an expensive packing material would cost more than a plate design. Since the usual justification for packed units is their lower cost, going to an expensive design would require unusual circumstances.

Turndown, defined as the ratio of maximum to minimum vapor rates, is a term used to describe the rate flexibility of a distillation unit. For a bubble-cap column the turndown is about 5:1, and for the ballast type, it can run as high as 9:1. Precise data for some of the other plate types are not readily available, but they would fall within the range of 1.5:1 for sieve units and the 9:1 mentioned for ballast trays. The various plate designs would bear much the same relationship with regard to changing products.

Packed columns compare to the least flexible of the plate units. The different packing designs vary primarily in height required for a transfer unit and in pressure drop characteristics. All of the packed types have a rather narrow region of effective operation. They have the additional disadvantage of operating less efficiently at the low liquid loadings that are usually used for distillation. Outstanding features of packed columns are their lower cost compared to plate units, especially in small diameters, and their low pressure-drop characteristics.

A problem that confronts the designer of batch distillation equipment is the changing composition throughout the process. To design properly, he must determine the most difficult condition at each part of the process. Carried to an extreme, the characteristics of the mixtures would have to be determined at a number of points during the distillation. Realistically, investigation at the terminal conditions and the midpoint will usually provide sufficient information.

The relationship between rates of flow and the required number of theoretical plates holds considerable importance in the economics of column design. As illustrated in the foregoing discussion, the designer has a choice of several theoretical plate-vapor loading combinations to produce a given separation. An increase in the vapor loading requires not only an increased diameter but also affects the size of the heating and cooling equipment. On the other hand, obtaining more theoretical plates requires a higher column and will increase the cost of structural supports.

Nomenclature

D	Distillate rate, moles/hr.
L	Liquid flow, moles/hr.
V	Vapor rate, moles/hr.
$\overline{V}$	Quantity of vapor, moles.
W	Contents of still pot, moles.
x	Mole fraction of substance in liquid.
y	Mole fraction of substance in vapor.
α	Relative volatility.
θ	Time, hr.

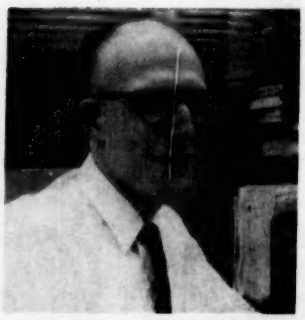
Subscripts

D	Relating to distillate.
i	Initial.
w	Relating to pot liquors.

References

1. Rayleigh, *Phil. Mag.*, 6th series, **4**, 521 (1902).
2. Bogart, M. J., *Trans. AIChE*, **33**, 131 (1937).
3. Robinson, S. C. and E. R. Gilliland, "Elements of Fractional Distillation," 4th edition, McGraw-Hill, New York, 1950.
4. Kirschbaum, E., "Distillation and Rectification," Chemical Publishing Co., New York, 1948.
5. Perry, J. H., "Chemical Engineers' Handbook," 3rd edition, McGraw-Hill, New York, 1950.
6. Nord, M., *Chem. Eng.*, Feb. 1951, pp. 144-146.
7. Smoker, E. H., *Trans. AIChE*, **34**, 165 (1938).
8. Smoker, E. H. and A. Rose, *Trans. AIChE*, **36**, 285 (1940).
9. Rose, A. and R. C. Johnson, *Chem. Eng. Progress*, **49**, 15 (1953).

Meet the Author



BENJAMIN BLOCK *is a process engineer at Abbott Laboratories, North Chicago, Ill. He received a B.S. degree in 1949 from the University of Illinois and an M.S. from Northwestern in 1950 where he continued his studies as a research fellow. His honors include membership in Phi Lambda Upsilon and Sigma Xi.*

Here is a quick and simple method for estimating the approximate size and horsepower requirements for air-cooled heat exchangers with standard-type fin-tubes.

Estimating Air-Cooled Exchangers Made Easy

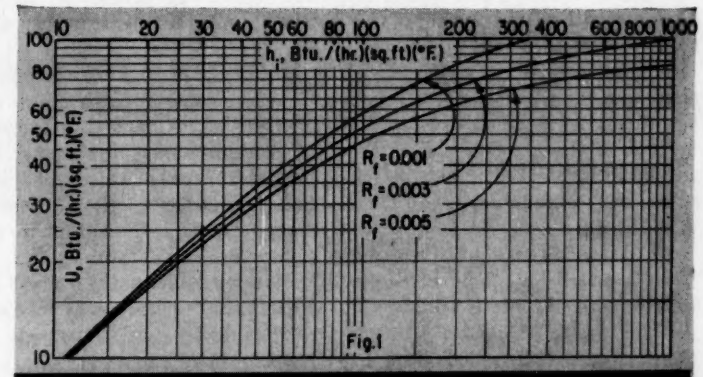
JOSEPH W. MURTHA
SY H. FRIEDMAN
Bechtel Associates

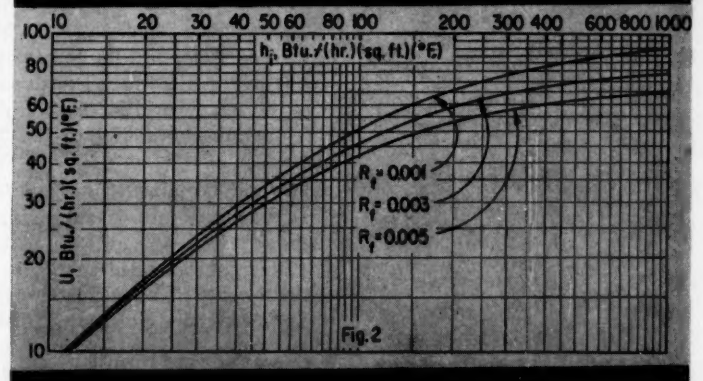
Here is a way to estimate quickly the approximate size and horsepower requirements for an air-cooled heat exchanger. While you might at first think that the method we are about to describe is limited to a particular tube size, and therefore quite restricted, it is not so limited in application as it appears.

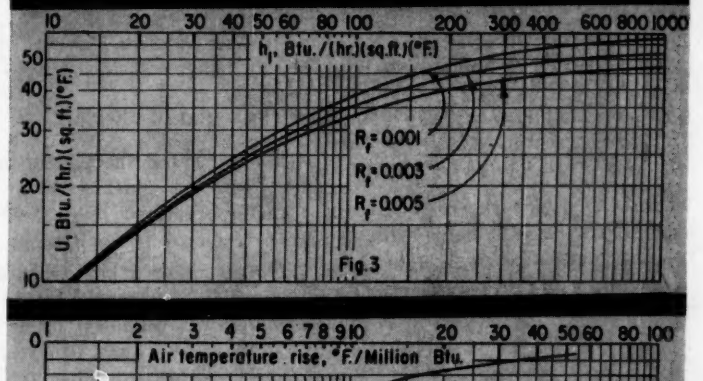
The vast majority of tubes used in air-cooled heat exchangers are either ¾-in. or 1-in. O.D. with aluminum fins where temperatures are less than 500 F. Main mechanical variants are fin thickness, height and number of fins per inch. Though the curves that we give are based on a 1-in., 12-BWG tube with ⅝-in. aluminum fins, 0.016-in. thick, spaced at 11/in., the data are adaptable to other fin configurations.

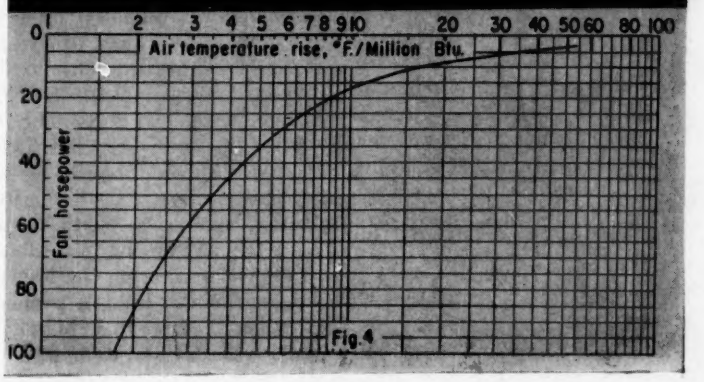
Calculations are straightforward:

1. Assume an air-side-film heat transfer coefficient (h_o).
2. Calculate or estimate the inside-film heat transfer coefficient (h_i), then use Eq. (1) to obtain h_{io}, *i.e.*, h_i referred to outside bare-tube surface.
3. Use Fig. 1, 2 or 3 to obtain the over-all heat transfer rate based on the equivalent outside bare-tube surface.
4. Assume an air-temperature rise.
5. Calculate log mean temperature difference.
6. Calculate the equivalent outside bare-tube surface. For the tubes we are discussing, the equivalent bare-tube area is 6.063 sq. ft./linear ft. of tube.









7. Calculate the horsepower requirements based on 0.0322 hp./sq. ft. of bare tube for a four-layer section and 0.0168 hp./sq. ft. for a six-layer section.

8. Refer to Fig. 4 and obtain the air-temperature rise for the horsepower determined in Step 7.

9. Compare the air-temperature rise from Step 8 with the air-temperature rise assumed in Step 4.

10. If Steps 4 and 8 yield different answers, assume a new air-temperature rise and recalculate Steps 5, 6, 7 and 8.

11. Repeat Step 10 until assumed and calculated air-temperature rise agree within desired limits.

12. Use Eqs. (2) and (3) to estimate over-all air-cooled heat exchanger dimensions.

Try an example

We have to cool 10,000 bbl./day of 40° API kerosene from 300 F. to 150 F. Maximum inlet air temperature is 100 F. The fouling factor, R_f, is 0.001 and the inside-film heat transfer coefficient is 150 Btu./(hr.) (sq. ft.) (°F.).

Convert flow from barrels/day to lb./hr.:

$$\frac{10{,}000 \text{ B./D.} \times 42 \text{ gal./B.} \times 6.87 \text{ lb./gal.}}{24 \text{ hr./day}} = 120{,}200 \text{ lb./hr.}$$

Calculate exchanger duty:

$$120{,}200 \text{ lb./hr.} \times 0.55 \text{ Btu./(lb.) (°F.)} \times 150 \text{ F.} = 9{,}917{,}000 \text{ Btu./hr.}$$

Assume that $1/h_o = 0.009$ (Step 1). Then correct h_i to h_{io}:

$$h_{io} = h_i\,(A_i/A_o) \qquad (1)$$

where (A_i/A_o) is the ratio of inside tube surface to outside bare-tube surface, 0.782.

Solving Eq. (1), we get $h_{io} = 150\ (0.782) = 117.3$ (Step 2), and $U = 54$ Btu./(hr.) (sq. ft.) (°F.), from Fig. 2 (Step 3).

Assume a 60 F. air-temperature rise (Step 4) and then calculate the log mean temperature difference (Step 5). The LMTD is 87.5 F.

The outside bare-tube surface is:

$$\text{Area} = Q/U\Delta T = 9{,}917{,}000/(54)(87.5) = 2{,}100 \text{ sq. ft.}$$

From Step 7, we find that the horsepower for a four-layer section is $0.0322 \times 2{,}100 = 68$ hp.

From Fig. 4, we find that the air-temperature rise is 2.50 F./1,000,000 Btu., or $2.50 \times 9.917 = 25$ F.

The calculated air-temperature rise of 25 F. does not agree with the assumed rise of 60 F. Therefore, we repeat the procedure using a new assumed temperature rise of 30 F.

Plugging in 30 F. to the calculations, we come up with a new area of 1,870 sq. ft., a new horsepower of 60 and a new air-temperature rise of 29 F. This air-temperature rise is sufficiently close to the assumed rise of 30 F. so that we need not do the calculations again.

Now we estimate the over-all heat exchanger dimensions as follows:

$$\text{Over-all dimensions} = L \times W \qquad (2)$$

$$W = (A_o)\,(S.R.)/(L)\,(100) \qquad (3)$$

where A_o is the equivalent bare-tube surface in sq. ft., $S.R.$, is the surface ratio, fin tube to bare tube, L is the nominal tube length and W is the bundle width.

Putting our data into Eq. 3, we get:

$$W = (1{,}850)\ (23.1)/(100)\ (20) = 21.6 \text{ ft.}$$

Thus, our unit is approximately 20×22 ft.

You must realize that this procedure only gives estimated figures. You need more detailed calculations to completely specify an air-cooled heat exchanger, and even then the unit finally selected might have to be a manufacturer's closest standard unit that will do the job.

Background of the Method

We calculated the plotted values for Figs. 1, 2 and 3 with the heat transfer equation:

$$1/U = 1/h_{io} + 1/h_o + R_m + R_f \qquad (4)$$

The air-side-film heat transfer coefficient, h_o, is governed by the core face-velocity, which is measured in ft./min. at 70 F. and 14.7 psia. To simplify the presentation, we selected three values for $1/h_o$—0.015, 0.009 and 0.006 (hr.) (sq. ft.) (°F.)/Btu.—representing low, average and high core face-velocities, respectively. We assumed tube metal resistance, R_m, to be 0.0007, but any change in this value will have little effect on the over-all U. Parameters in Figs. 1, 2 and 3 are fouling factors, R_f of 0.001, 0.003 and 0.005.

As you might expect, the value of U increases as R_f decreases. Higher air-side-film heat transfer coefficients (lower $1/h_o$'s) will also give higher U values.

Two other important items in the design of air-cooled heat exchangers are cooling approach and log mean temperature difference (LMTD).

What kind of cooling approach is best? As a general rule, do not have a temperature difference between the fluid outlet temperature and maximum surrounding air temperature of less than about 40 F. For example, if the air temperature is 95 F., the minimum allowable fluid outlet temperature is about 135 F. There are cases where it might be economically justifiable to go to a closer approach, but for this quick method, use 40 F. as the minimum approach.

Finally, you must consider the LMTD. Except where there is a considerable temperature cross and limited pressure drop, the correction to the LMTD for cross flow will be negligible. We assumed the correction factor to be 1.0.

Nomenclature

h_o	Air-side-film heat transfer coefficient, Btu./(hr.)(sq. ft.)(°F.).
h_i	Inside-film heat transfer coefficient, Btu./(hr.)(sq. ft.)(°F.).
h_{io}	Inside-film heat transfer coefficient referred to outside bare tube surface, Btu./(hr.)(sq. ft.)(°F.)
R_f	Inside fouling resistance, (hr.)(sq. ft.)(°F.)/Btu.
R_m	Tube metal resistance, (hr.)(sq. ft.)(°F.)/Btu.
U	Over-all heat transfer rate, Btu./(hr.)(sq. ft.)(°F.).

Meet the Authors

JOSEPH W. MURTHA *is a chemical engineering graduate of New York University. He is now a process engineer with Bechtel Assoc. in New York, and is a member of Tau Beta Pi engineering honor fraternity.* SY H. FRIEDMAN *is senior engineer in Bechtel's process department. He is a licensed engineer in New York and a member of the N. Y. Society of Professional Engineers. Mr. Friedman is a frequent contributor to* CE.

Numerical Mathematics for Chemical Engineers

Keep abreast of the computer boom with these proven techniques.

D. L. WHITLEY
Dow Chemical Co., Freeport, Tex.

The digital computer is revolutionizing engineering. Despite its very great advantages in the solution of complicated problems, however, it can perform only elementary arithmetic steps. To take advantage of the help a computer can offer, therefore, the engineer must translate his calculus and simultaneous equations into a new language—numerical mathematics.

Numerical math offers significant advantages over analytical methods. For example, if you wish to integrate a function whose integrand does not appear in a table of integrals, a solution by the analytical method is impossible. With numerical math, however, using a method such as Simpson's rule where values are obtained by substitution, a solution is possible.

Although numerical math theory has been developed for about 300 years, it has not been widely used because the actual techniques are cumbersome and time consuming. Of course, time is no problem with computers that operate at speeds between, say, 300 and 250,000 arithmetic steps per second.

Curve Fitting for Complicated Functions

The analytical form of many functions is so complicated that they cannot be used. In this case, it is desirable to replace the function with another that can be more readily handled. Curve fitting, interpolation or the computation of the equation of the curve consists, then, of representing a function by using values of the function for definite values of the independent variable. Several methods are available, of which we will consider two in detail.

Power Series—Practically all math functions can be expressed "expanded" into a power series. It is frequently easier to find the numerical value of a function by expanding it into a power-series polynomial

$$f(x_i) = \Sigma_0^n a_n x^n = a_0 + a_1 x_i + a_2 (x_i)^2 + \ldots a_n (x_i)^n \qquad (1)$$

and evaluating the constants, $a_o \ldots a_n$. Logarithmic, transcendental, hyperbolic and elliptic functions are cases in point.

The power series can be utilized to fit any set of data by taking a sufficient number of terms. The required number of terms is given by the following theorem:

If the nth differences of a tabulated function are constant when the values of the independent variable are taken in arithmetic progression, the function is a polynomial of degree n.

An example will serve to illustrate this method. Given the following polynomial:

$$y = 2x^4 - 3x^3 + 5x^2 - 2x + 3 \qquad (2)$$

it can be seen that the polynomial is of the fourth degree. The values of y are computed by direct substitution. The second, third and fourth differences are computed from these values. Thus,

x	y	Δy	$\Delta^2 y$	$\Delta^3 y$	$\Delta^4 y$
1.0	5.0000				
		0.7852			
1.1	5.7852		0.1928		
		0.9780		0.0372	
1.2	6.7632		0.2300		0.0048
		1.2080		0.0420	
1.3	7.9712		0.2720		0.0048
		1.4800		0.0468	
1.4	9.4512		0.3188		
		1.7988			
1.5	11.2500				

Therefore, Eq. 2 can be written in a power-series form as a fourth-degree polynomial

$$y = a_0 + a_1 x_i + a_2 (x_i)^2 + a_3 (x_i)^3 + a_4 (x_i)^4 \qquad (3)$$

The only remaining problem is to determine the value of the power-series constants, $a_o, a_1 \ldots a_4$. By a method discussed later, this has been done, giving:

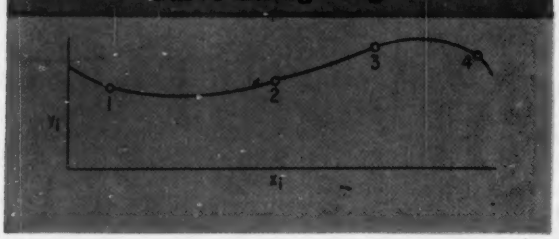
$$y = 3.0 - 2.0063(x_i) + 5.014(x_i)^2 - 3.0099(x_i)^3 + 2.0022(x_i)^4$$

By substituting x_i values in the above equation, the correct values of y_i will be obtained. The only limitation is that x_i values must be between 0 and 1.5.

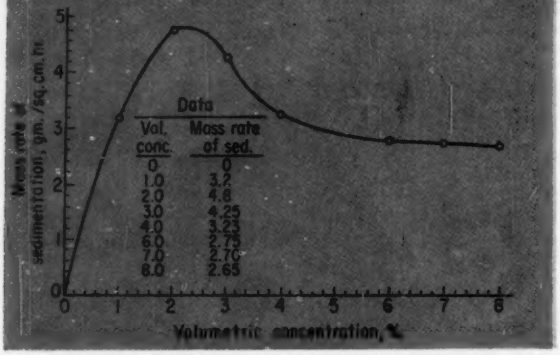
When an infinte series is used, the first question that arises is to determine whether it is convergent. In general, a power series represents a continuous function of x in the region of convergence of the series. The *Cauchy ratio test* is used to test a power series for convergence.

A power series converges if the following is true:

Curve fitting—Fig. 1



Sedimentation problem—Fig. 2



$$\lim_{n \to \infty} \left| \frac{a_n}{a_{n-1}} x_i \right| < 1 \qquad (4)$$

and diverges if

$$\lim_{n \to \infty} \left| \frac{a_n}{a_{n-1}} x_i \right| > 1 \qquad (5)$$

The author has verified this test a number of times on the computer.

It would be apropos to discuss briefly a power-series method of curve fitting, see Fig. 1. For the number of points from the curve (or tabular data) typed into the computer, there are an equal number of simultaneous equations set up. In the example above, the four sets of (x_i, y_i) are used to set up these 4 equations:

$$f(x_1) = a_1(x_1) + a_2(x_1)^2 + a_3(x_1)^3 + a_4(x_1)^4 \qquad (6)$$
$$f(x_2) = a_1(x_2) + a_2(x_2)^2 + a_3(x_2)^3 + a_4(x_2)^4 \qquad (7)$$
$$f(x_3) = a_1(x_3) + a_2(x_3)^2 + a_3(x_3)^3 + a_4(x_3)^4 \qquad (8)$$
$$f(x_4) = a_1(x_4) + a_2(x_4)^2 + a_3(x_4)^3 + a_4(x_4)^4 \qquad (9)$$

Solving these four simultaneous equations, yields a_1, a_2, a_3 and a_4, while a_0 is simply (x_4) at $x_4 = 0$. Therefore, the curve-fitting power series is

$$f(x_4) = a_0 + a_1(x_4) + a_2(x_4)^2 + a_3(x_4)^3 + a_4(x_4)^4 \qquad (10)$$

The only limitation is that the number of points must be equal to or greater than the degree of the polynomial. If more (x_i, y_i) data points are used than the degree, the only result is that the power-series coefficients near a_n become exceedingly small. This has no effect on the accuracy of the correlation. All math function such as hyperbolic, elliptic, transcendental, etc., can be solved by this method.

Newton's Formula for Forward Interpolation—Consider a function $y = f(x)$. The formula requires a table of values of $y_0, y_1, y_2, \ldots y_n$ for equidistant values $x_0, x_1, x_2, \ldots x_n$ of the independent variable x.

To use Newton's interpolation formula, it is very helpful to construct a difference table. Table I is a difference table where $y = x^3$. The numerical values are on the left, the nomenclature on the right.

The tabulated function is to be fitted by an nth-degree polynomial, $f(x)$. This can be written

$$f(x) = a_0 + a_1(x - x_0) + a_2(x - x_0)(x - x_1) + a_3(x - x_0)(x - x_1)(x - x_2) + \ldots + a_n(x - x_0)(x - x_1) \ldots (x - x_{n-1})$$

Let $h = x_1 - x_0 = x_2 - x_1 = \Delta x_i$ and $p = (x - x_0)/h$. The given value of the independent variable is x.

By derivation:

$$y = f(x) = y_0 + p\Delta^1 y_0 + \frac{p(p-1)}{2!}\Delta^2 y_0 + \frac{p(p-1)(p-2)}{3!}\Delta^3 y_0 + \frac{p(p-1)(p-2)(p-3)}{4!}\Delta^4 y_0 + \ldots + \frac{p(p-1)\ldots(p-n+1)}{n!}\Delta^n y_0 \qquad (11)$$

Note that y_0, Δy_0, $\Delta^2 y_0$, etc., are the differences in the top diagonal column *forward* from the beginning of the tabular set. The set is suitable only for point values, not the equation of an entire curve.

An example will illustrate the method. The sedimentation rate of a suspension is related to the volumetric concentration of the sediment. The data and curve for the sedimentation of a suspension of precipitated calcium carbonate in water are shown in Fig. 2.

We are required to (1) find the equation of the curve over the range of the data given, (2) calculate sedimentation rate at 2.5% volumetric concentration.

To find the power-series polynomial, set up the seven simultaneous linear equations

$$a_1(1.0) + a_2(1.0)^2 + a_3(1.0)^3 + a_4(1.0)^4 + a_5(1.0)^5 + a_6(1.0)^6 + a_7(1.0)^7 = 3.2$$
$$a_1(2.0) + a_2(2.0)^2 + a_3(2.0)^3 + a_4(2.0)^4 + a_5(2.0)^5 + a_6(2.0)^6 + a_7(2.0)^7 = 4.8$$
$$a_1(3.0) + a_2(3.0)^2 + a_3(3.0)^3 + a_4(3.0)^4 + a_5(3.0)^5 + a_6(3.0)^6 + a_7(3.0)^7 = 4.25$$
$$a_1(4.0) + a_2(4.0)^2 + a_3(4.0)^3 + a_4(4.0)^4 + a_5(4.0)^5 + a_6(4.0)^6 + a_7(4.0)^7 = 3.23$$
$$a_1(6.0) + a_2(6.0)^2 + a_3(6.0)^3 + a_4(6.0)^4 + a_5(6.0)^5 + a_6(6.0)^6 + a_7(6.0)^7 = 2.75$$
$$a_1(7.0) + a_2(7.0)^2 + a_3(7.0)^3 + a_4(7.0)^4 + a_5(7.0)^5 + a_6(7.0)^6 + a_7(7.0)^7 = 2.70$$
$$a_1(8.0) + a_2(8.0)^2 + a_3(8.0)^3 + a_4(8.0)^4 + a_5(8.0)^5 + a_6(8.0)^6 + a_7(8.0)^7 = 2.65$$

Solving these, yields: $a_1 = 2.1165$, $a_2 = 3.0187$, $a_3 = -2.6148$, $a_4 = 0.78609$, $a_5 = -0.11439$, $a_6 = 0.0081748$, $a_7 = -0.00023038$.

The value a_0 is where $x = 0$. In this example, $a_0 = 0$ and the equation of the curve is

$$y_i = 0 + 2.1165(x_i) + 3.0187(x_i)^2 - 2.6148(x_i)^3 + 0.78609(x_i)^4 - 0.11439(x_i)^5 + 0.0081748(x_i)^6 - 0.00023038(x_i)^7$$

The sedimentation rate at 2.5% volumetric concentration is obtained by substituting $x_i = 2.5$. This gives $y_i = 4.6927$ gm./sq. cm., hr.

We next consider the solution to this problem using

Newton's interpolation formula. This technique is suitable only for computing point values of the function and not for the computation of an equation of a curve. Therefore, only the value of y at $x = 2.5$ will be calculated. First, set up the difference table.

x	y	Δ^1y	Δ^2y	Δ^3y	Δ^4y
2.0	4.80				
		−0.55			
3.0	4.25		−0.47		
		−1.02		+1.13	
4.0	3.23		0.66		−1.55
		−0.36		−0.42	
5.0	2.87		0.24		+0.25
		−0.12		−0.17	
6.0	2.75		0.07		+0.10
		−0.05		−0.07	
7.0	2.70		0		
		−0.05			
8.0	2.65				

$$p = \frac{2.5 - 2.0}{1.0} = 0.5 \text{ and, by Eq. 11}$$

$$y = 4.8 + (0.5)(-0.55) + \frac{0.5(0.5 - 1)}{2}(-0.47) + \frac{0.5(0.5 - 1)(0.5 - 2.0)}{(3)(2)}(1.13) + \frac{0.5(0.5 - 1)(0.5 - 2)(0.5 - 3.0)}{(4)(3)(2)}(-1.55)$$

$= 4.711025$ gm./sq. cm. hr.

Even though the fourth differences were not constant, the table was not extended because of space limitations. However, the accuracy obtained was satisfactory.

It is evident from this example that both the power-series polynomial and Newton's formula are quite accurate—the measured value is 4.700.

Other Methods for Curve Fitting

Method of Least Squares—This method is based on the assumption that the best representative curve is that for which the sum of the squares of the residuals (errors) is a minimum. The residuals are squared to eliminate concern for their sign. See Scarborough's book, page 466.[1]

This method is much more complicated for higher-degree polynomials and is usually used for no higher degree than second. The least squares method is less accurate than the power-series polynomial or Newton's interpolation, and is best used to correlate or give the "best fit" of a set of experimental data.

Lagrange's Formula of Interpolation—Many interpolation formulas are applicable only when the values of the independent variable are given at equidistant intervals. Lagrange's formula does not have this limitation but uses only such data as may be available.

Let (x_0, y_0), (x_1, y_1), (x_2, y_2) . . . (x_n, y_n) equal $n + 1$ pairs of values of any two variables x and y, where $y = f(x)$. The given function may be replaced by a polynomial of the nth degree:

$$(x) = \frac{(x - x_1)(x - x_2) \ldots (x - x_n)}{(x_0 - x_1)(x_0 - x_2) \ldots (x_0 - x_n)} y_0 + \frac{(x - x_0)(x - x_2) \ldots (x - x_n)}{(x_1 - x_0)(x_1 - x_2) \ldots (x_1 - x_n)} y_1 + \frac{(x - x_0)(x - x_1)(x - x_3) \ldots (x - x_n)}{(x_2 - x_0)(x_2 - x_1)(x_2 - x_3) \ldots (x_2 - x_n)} y_2 + \ldots + \frac{(x - x_0)(x - x_1) \ldots (x - x_{n-1})}{(x_n - x_0)(x_n - x_1) \ldots (x_n - x_{n-1})} y_n \quad (14)$$

Lagrange's formula is used primarily to (1) obtain the value of the independent variable corresponding to a given value of the function and (2) obtain any value of a function when the given values of the independent variable are not equidistant.

Although Lagrange's formula is tedious, a more serious limitation is that, if the values are not close together, the results tend to be very inaccurate. The formula should be used, therefore, only where it is impossible to employ another method.

Stirling's Central Difference Formula—Two forms of Newton's formula are used for interpolation near the beginning and near the end of a set of tabular values. Stirling's formula is particularly suited for interpolating values near the middle of a tabulated set. This method is outlined by Scarborough, page 70.[1]

Taylor's Series—One method of expanding functions into a power series is by the use of Taylor's series. The last term in the series is the remainder or size of error after n terms, and Taylor's series thus has an advantage over some other methods. It can, for example, be programmed on a computer so that terms can be added automatically until the last term (error term) is less than some specified limit.

A note of caution on the use of all curve-fitting methods should be expressed. The correlation accuracy between (x_i, y_i) data points must be checked.

Calculate Derivatives by Numerical Differentiation

The technique of calculating the derivatives of a function from a set of given values of that function is numerical differentiation. The general procedure

Difference table for forward interpolation—Table I

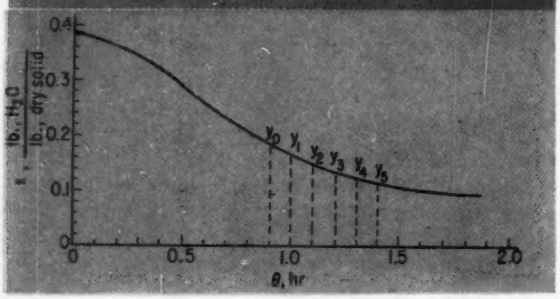
x	$y = x^3$	Δ^1y	Δ^2y	Δ^3y	Δ^4y	x	y	Δ^1y	Δ^2y	Δ^3y	Δ^4y
1.10	1.331					x_0	y_0				
		0.397						Δ^1y_0			
1.20	1.728		0.072			x_1	y_1		Δ^2y_0		
		0.469		0.006				Δ^1y_1		Δ^3y_0	
1.30	2.197		0.078		0	x_2	y_2		Δ^2y_1		Δ^4y_0
		0.547		0.006				Δ^1y_2		Δ^3y_1	
1.40	2.744		0.084			x_3	y_3		Δ^2y_2		
		0.631						Δ^1y_3			
1.50	3.375					x_4	y_4				

Data for transfer-units problem—Table II

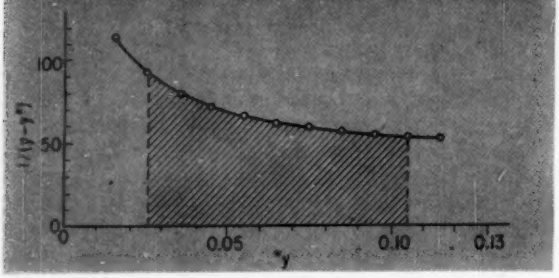
Given		Calculate from the Data	
y	y^*	$y - y^*$	$\frac{1}{y - y^*}$
0.015 (x_{-1})	0.006342	0.008658	115.5 (y_{-1})
0.025 (x_0)	0.014328	0.010672	93.7 (y_0)
0.035 (x_1)	0.02250	0.012500	80.0 (y_1)
0.045 (x_2)	0.031264	0.013736	72.8 (y_2)
0.055 (x_3)	0.040141	0.014859	67.3 (y_3)
0.065 (x_4)	0.049202	0.015798	63.3 (y_4)
0.075 (x_5)	0.058444	0.016556	60.4 (y_5)
0.085 (x_6)	0.067833	0.017167	58.25 (y_6)
0.095 (x_7)	0.077425	0.017575	56.9 (y_7)
0.105 (x_8)	0.087127	0.017873	55.95 (y_8)
0.115 (x_{8+1})	0.096819	0.018181	55.0 (y_{8+1})

y^* = equilibrium data

Drying-rate problem—Fig. 3



Transfer-units problem—Fig. 4



is to represent the function by an interpolation formula and to differentiate as many times as desired.

Derivative of Newton's Forward Interpolation Formula—Differentiation of Newton's formula yields

$$f^{I}(x_0) = \frac{1}{h}\left(\Delta y_0 - \frac{1}{2}\Delta^2 y_0 + \frac{1}{3}\Delta^3 y_0 - \frac{1}{4}\Delta^4 y_0 + \frac{1}{5}\Delta^5 y_0 - \ldots\right) \quad (15)$$

Successive differentiation yields

$$f^{II}(x_0) = \frac{1}{h^2}\left(\Delta^2 y_0 - \Delta^3 y_0 + \frac{11}{12}\Delta^4 y_0 - \frac{5}{6}\Delta^5 y_0 + \ldots\right) \quad (16)$$

$$f^{III}(x_0) = \frac{1}{h^3}\left(\Delta^3 y_0 - \frac{3}{2}\Delta^4 y_0 + \frac{7}{4}\Delta^5 y_0 - \ldots\right) \quad (17)$$

$$f^{IV}(x_0) = \frac{1}{h^4}\left(\Delta^4 y_0 - 2\,\Delta^5 y_0 + \ldots\right) \quad (18)$$

Douglas-Avakian Method—This method uses a fourth-degree polynomial that is fitted to seven equidistant points by the method of least squares. The polynomial is

$$y = a + bx + cx^2 + dx^3 + ex^4$$

The points are spaced at equal intervals h with the coordinates chosen so that $x = 0$ for the central point of the seven. The seven values of x can be written as $-3h$, $-2h$, $-h$, 0, h, $2h$ and $3h$. Let k represent the coefficient of h in the values of x, i.e., −3, −2, −1, 0, 1, 2, 3.

$$\text{By derivation, } \left(\frac{dy}{dx}\right)_0 = \frac{397\,\Sigma kg}{1{,}512\,h} - \frac{7\,\Sigma k^2 y}{216\,h} \quad (19)$$

An example will illustrate these two methods. A cake of crystalline material is to be air dried by drawing air over the cake. In order to design the drying systems, the experimental data shown in Fig. 3 was obtained. From this, calculate the drying rate at 0.9 hr., i.e., $dx/d\theta = 0.9$, where θ is the time in hours.

First, we will solve the problem by the derivative of Newton's formula. Divide part of the curve into five subincrements beginning at $\theta = 0.9$ hr., as shown.

$$\left(\frac{dy}{dx}\right)_0 = \frac{1}{h}\left[\Delta^1 y_0 - \frac{1}{2}\Delta^2 y_0 + \frac{2}{3!}\Delta^3 y_0 - \frac{6}{4!}\Delta^4 y_0 + \frac{12}{5!}\Delta^5 y_0\right] \quad (20)$$

Next, set up a difference table.

x	y	$\Delta^1 y$	$\Delta^2 y$	$\Delta^3 y$	$\Delta^4 y$	$\Delta^5 y$
0.9	0.18335					
		−0.01995				
1.0	0.1634		0.00250			
		−0.01745		0.00030		
1.1	0.14595		0.00280		0.00007	
		−0.01465		0.00037		−0.00021
1.2	0.1313		0.00317		−0.00014	
		−0.01148		0.00023		
1.3	0.11982		0.00340			
		−0.0808				
1.4	0.11174					

$$\left(\frac{dy}{dx}\right)_{\theta=0.9} = \frac{1}{0.1}\left[-0.01995 - \frac{0.0025}{2} + \frac{2(0.0003)}{6} + \frac{6(0.00007)}{24} + \frac{6(0.00021)}{120}\right] = -0.2111$$

For the Douglas-Avakian method, the following table is prepared from the curve and tabular data:

x	x^1	y	k	ky	$k^2 y$
0.3	−3	0.3450	−3	−1.0350	−9.3150
0.5	−2	0.2859	−2	−0.5718	−2.2872
0.7	−1	0.2303	−1	−0.2303	−0.2303
0.9	0	0.1834	0	0	0
1.1	1	0.1460	1	0.1460	0.1460
1.3	2	0.1189	2	0.2396	0.9584
1.5	3	0.1071	3	0.3213	2.8917
				−1.1302	−7.8364

$$\frac{dy}{dx} = \frac{(397)(-1.1302)}{(1,512)(0.2)} - \frac{(7)(-7.8364)}{(216)(0.2)} = -0.2225$$

Comparing results, we find a value of −0.2111 by Newton's formula; −0.2225 by Douglas-Avakian; and a measured value of −0.21.

The fact that the Douglas-Avakian method is based on the method of least squares explains its relative inaccuracy. However, caution should be used with both methods. When the base polynomial, i.e., Newton's formula, or the method of least squares deviates from the formula $y = f(x)$ by even a small amount, the derivatives can be significantly in error.

Use Numerical Integration

The process of computing the value of a definite integral from a set of numerical values of the integrand is *numerical integration.* The integrand is represented by an interpolation formula and the formula is integrated between the desired limits.

Simpson's Rule—This method can be summarized by saying that it is based on connecting the (x_i, y_i) points by a series of parabolas.

Functions of this type are second-degree polynomials

$$y = a + bx + cx^2$$

There is an inherent error, therefore, if the math function is greater than a second degree. The final form of the equation for Simpson's rule is

$$\int_a^b y\,dx = \frac{h}{3}[y_o + 4(y_1 + y_3 + \ldots + y_{n-1}) + 2(y_2 + y_4 + \ldots y_{n-2}) + y_n] \quad (21)$$

As stated above, Simpson's rule is exact only for first and second degree polynomials. The degree of the function is unknown in many applications and, therefore, some means of computing the error is necessary. The following equation is given without derivation:

$$Es = -\frac{h}{90}[y_{-1} + y_{n+1} - 4(y_0 + y_n) + 7(y_1 + y_{n-1}) - 8(y_2 + y_4 + \ldots + y_{n-2}) + 8(y_3 + y_5 + \ldots y_{n-3})] \quad (22)$$

where $h = \Delta x_i$ and $n \geqq 6$.

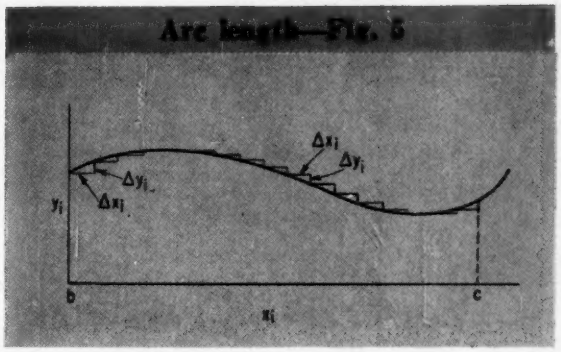
An example will illustrate the method. A packed tower is to absorb gas "*A*" from a burner gas. Tower-inlet gas contains 10.5% (mole) "*A*" and tower-outlet gas contains 2.5% (mole) "*A*". Calculate the number of transfer units, N_{OG}, required. Data are shown in Fig. 4 and Table II.

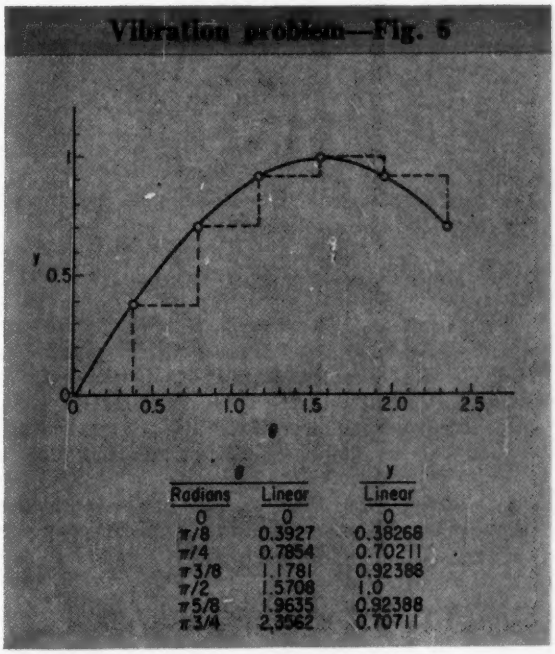
Assume the gas film is controlling, therefore:

$$N_{OG} = \int_{y(1)}^{y(2)} \frac{dy}{y - y^*}$$

$$N_{OG} = \int_{0.025}^{0.105} y\,dx = \frac{0.01}{3}[93.7 + 4(80.0 + 67.3 + 60.4 + 56.9) + 2(72.8 + 63.3 + 58.25) + 55.95] = 5.3225 \text{ transfer units}$$

$$Es = -\frac{0.01}{90}[115.5 + 55.0 - 4(93.7 + 55.95) + 7(80.0 +$$





θ Radians	θ Linear	y Linear
0	0	0
π/8	0.3927	0.38268
π/4	0.7854	0.70211
π 3/8	1.1781	0.92388
π/2	1.5708	1.0
π 5/8	1.9635	0.92388
π 3/4	2.3562	0.70711

Calculation of arc length—Table III

θ	Δθ	$(\Delta\theta)^2$	y	Δy	$(\Delta y)^2$	$\sqrt{(\Delta\theta)^2+(\Delta y)^2}$
0			0			
	0.3927	0.15421		0.38268	0.14644	0.54832
0.3927			0.38268			
	0.3927	0.15421		0.31943	0.10204	0.50610
0.7854			0.70211			
	0.3927	0.15421		0.22177	0.04918	0.45087
1.1781			0.92388			
	0.3927	0.15421		0.07612	0.00579	0.40000
1.5708			1.0			
	0.3927	0.15421		0.07612	0.00579	0.40000
1.9635			0.92388			
	0.3927	0.15421		0.22177	0.04918	0.45087
2.3562			0.70711			
						2.75616

Summary and recommended methods—Table IV

Operation	Recommended Method	Equation Number	Figure Number
Curve fitting	Power-series polynomial	1	1
Numerical differentiation	First derivative of Newton's interpolation formula	20	—
Numerical integration	Simpson's rule	21	4
	Inherent error in Simpson's rule	22	—
Arc length	Sum of incremental hypotenuses	25	5

$$56.9) - 8\,(72.8 + 63.3 + 58.25) + 8\,(67.3 + 60.4)] = 0.000333 \text{ transfer units}$$

The function is close to a 2nd-degree polynomial; therefore, the error was relatively small.

Other Methods of Numerical Integration

Weddle's Rule—In this method, the given function is replaced by $n/6$ arcs of sixth-degree polynomials. Weddle's rule is simple in form and more accurate than Simpson's rule. It has the disadvantage, however, of requiring that the number of subdivisions be a multiple of six. The method is described in Scarborough, p. 133.[1]

Tchebycheff's Formula—In this numerical-integration formula, the coefficients of all the y's are equal. See Scarborough, page 155.[1]

$$\int_a^b y\,dx = \frac{b-a}{n}\left[\phi\,(y_1) + \phi\,(y_2) + \ldots \phi\,(y_n)\right] \qquad (23)$$

The points of subdivision of the interval of integration are symmetrically placed with respect to the midpoint of the interval. Since the functional values y all have the same coefficient ϕ, this method is suitable for data that will have both positive and negative errors.

Measurement of Arc Length

For the function $y = f\,(x)$, the curvilinear distance taken by the function between two values of the independent variable x is called the arc length.

To determine this value, closely spaced $(x_i,\ y_i)$ points are computed or measured in some manner. The distance between adjacent points is computed as the hypotenuse, with Δx and Δy as two sides of a right triangle. The sum of the incremental hypotenuses is the arc length. An approximate length is

$$S \text{ (arc length)} = \Sigma \sqrt{(\Delta x_a)^2 + (\Delta y_a)^2} \qquad (24)$$

When the number of division points is increased indefinitely, while the lengths of the individual segments tend to zero, the exact length is obtained. The method is illustrated by Fig. 5.

$$S = \lim_{n \to \infty} \sum_{a=1}^{n} \sqrt{(\Delta x_a)^2 + (\Delta y_a)^2} \qquad (25)$$

This method is not practical to use except when programmed on a computer.

The following will illustrate the calculation of the arc length: to analyze the vibration of a system, it is necessary to compute the displacement of a point between $\theta = 0$ and $\theta = \frac{3}{4}\,\pi$ radians. The position of the point is given by $y = \sin \theta$. Fig. 6 shows the curve and data for this problem, and the calculation is carried out as shown in Table III.

Displacement of the point (arc length) between $\theta = 0$ and $\theta = \frac{3}{4}\,\pi$ radians is 2.75616 linear units.

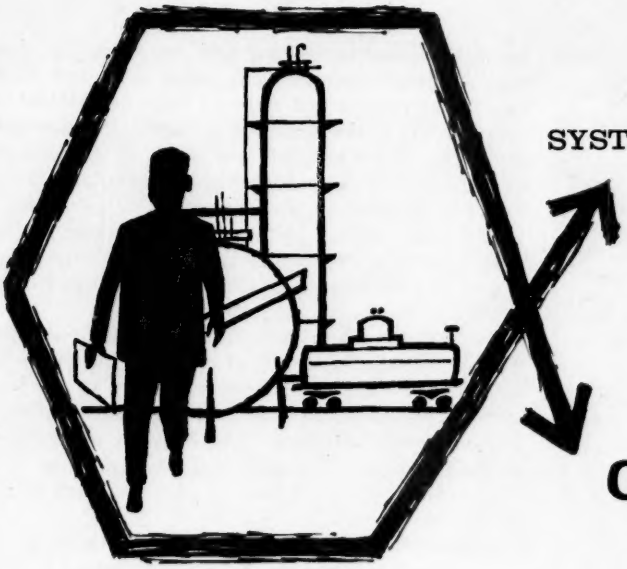
This article has illustrated the application of numerical math techniques. While alternate methods have been shown, the techniques listed in Table IV are those recommended for engineering problems. Each has been programmed and used on a digital computer by the author.

References

1. Scarborough, J. B., "Numerical Mathematical Analysis," John Hopkins Press, Baltimore, 1955.
2. Sokolnikoff, I. S., R. M. Redheffer, "Mathematics of Physics and Modern Engineering," McGraw-Hill, New York, 1958.
3. Milne, W. E., "Numerical Calculus," Princeton University Press, Princeton, N. J., 1949.
4. Milne, W. E., L. M. Thompson, "The Calculus of Finite Differences," Macmillan, London, 1951.
5. Mickley, H. S., T. K. Sherwood, C. E. Read, "Applied Mathematics in Chemical Engineering," McGraw-Hill, New York, 1957.
6. Householder, A. S., "Principles of Numerical Analysis," McGraw-Hill, New York, 1953.

Meet the Author

DONALD L. WHITLEY *is a senior design engineer with Dow Chemical Co., Freeport, Tex. During his eight years with Dow, he has participated in the design of several plants and has been active in the programming of process design problems for a Bendix G-15D digital computer. Prior to Dow, Whitley worked for the engineering departments of Phillips Petroleum and Brown & Root, Inc. He has a B.S. in chemical engineering from Texas A&M and is a member of AIChE, South Texas Section. He is a registered P.E. in Texas.*



SYSTEMS ENGINEERING, PART 12

Computer Control

THEODORE J. WILLIAMS, *Monsanto Chemical Co.*

Following modification of instrumentation to improve plant performance (Part 6*), we said that the final control scheme made the Quandary Chemical Co. plant as nearly automatic as conventional instrumentation would allow. Off-line computer optimization might further improve manual setpoint adjustment of such controllers.

The next step in improvement of operation is actual plant control by the computer. Although control computers may have many worthwhile applications in the CPI (see, for example, Ref. 1), several basic considerations should be kept in mind.

First, an over-all digital computer installation will be more expensive than the usual plant instrumentation. And current research shows that in the absence of such factors as rapidly deteriorating catalysts, and with adequate detecting instruments, conventional control systems can give satisfactory plant control.

Of course, conventional control systems cannot optimize plant unit operations. Under present practice such optimizations need be carried out, however, only when major changes occur in conditions or requirements. Such major changes occur infrequently in most plants, but it should be remembered that long intervals between changes are caused by the difficulty of changing operating rates, and they may not represent true economic optima.

A digital computer control system must pay out the increased plant capitalization by increased return—through higher product purity, increased production, etc. Moreover, since research in process dynamics and control is usually necessary before installing such a system, payout should be compared with that from a similarly studied conventional system. A computer control system for a distillation column that uses stream composition analyzers shouldn't be compared with a conventional system that only samples tray temperatures. If such a comparison is made, it's not valid as to the true worth of computer control.

Added to these basic considerations are several specific economic and technical criteria that aid in computer control evaluations. Table I, on the next page, shows these.

Three Types of Computer Control

Let's consider methods by which a process control computer might carry out its assigned task. Three methods of digital computer control are suggested by recent literature:[2,3]

The Learning Computer—This computer has built-in capacity to develop a dynamic model of the controlled process by analyzing and operating upon data from the process. By perturbing the process in some predetermined fashion, the computer assures itself of an adequate range of data. It must, therefore, have the necessary units or programming to determine the proper perturbations and to use resulting data to develop and store a true mathematical model of the process. It must have, too, the facility to modify its program as additional data show desirability of such action. Once the model is determined, the computer must use these results to calculate proper valve settings, etc., in order to keep the process operating at its economic optimum at that moment.

The Dynamic Operational Control Computer—This

* Based on the 1959 Schoch Lecture at the University of Texas, the series has appeared in *Chemical Engineering*, Feb. 8, 1960, pp. 121-26; Mar. 7, pp. 131-6; Apr. 4, pp. 139-44; May 2, pp. 121-6; May 30, pp. 97-102; June 27, pp. 113-118; July 25, pp. 119-124; Aug. 22, pp. 127-132; Oct. 17, pp. 181-186; Nov. 14, pp. 227-232; Dec. 26, pp. 101-106.

Criteria for computer control—Table I

Economic criteria for permanent installation:

- Study must prove that there is economic gain over current operation in process output (from increased throughput, improved quality, etc.) greater than or equal to $2\,(S/n)$ dollars/yr.

where S is cost of the computer plus associated instrumentation in excess of previous requirements, n is number of years over which depreciated and the factor 2 accounts for taxes. Assuming generality for some conclusions we have drawn, concerning applicability of process control computers:

1. A return on total plant investment of at least 0.5%/yr. (before taxes) is probably possible on any process solely from monitoring and long-term economic optimizing abilities of the computer.
2. A check for process bottlenecks should be made if a systems study shows that return of greater than about 6%/yr. (before taxes) is possible. If such a return is possible, plant was not well-designed in first place. After plant engineering improvement, restudy the return on investment that can be credited to computer. (Although actual limits may vary from one firm to the next, a relationship such as this probably holds throughout the industry.)

Technical criteria for permanent installation:

- Study must show that computations carried out by the computer are absolutely necessary to realize the return.
- One or more of required computations must be made at frequencies of at least once per hour. Off-line computation, therefore, would not be practical.
- Computations must be implicit rather than explicit. They must be sufficiently complex so that several steps are required, and nomographic charts wouldn't suffice to determine the same result.
- "Fail-safe" operation must be demonstrable, in case of computer malfunction, even though maximum possible computer reliability is also required.

Criteria for experimental process control computer use:

- A previously set-up experimental program has shown desirability of determining a specific set of data, and installed instrumentation is capable of obtaining it.
- There is a time requirement on data collection, reduction, interpretation or analysis that precludes use of off-line computational equipment.

computer has capacity for regulating process operation to the same extent as the previous one. It operates, however, through use of a predetermined mathematical model rather than by having to establish its own operating procedures. It doesn't need facilities to perturb the process or to generate the process model, as are required by the previous machine. It may possibly be, therefore, a smaller or slower machine than the other.

The Steady-State Operational Control Computer—The use of this machine recognizes present limitations of computer size, speed and reliability. A steady-state model of the process is developed external to the computer and is used to program it. Used only as a monitoring element, the computer is placed in cascade with standard controllers, where its task is to calculate set-point adjustments continuously to make the plant meet its established economic goals. All direct operation of the process and recovery from operational upsets are left to the standard electronic or pneumatic controllers of the plant. A breakdown in the computer cannot result in plant shutdown, only in possible lowering of throughput or product quality.

This third method, being applied in several projects now, is an interim measure and will be superseded by one or both of the first two methods as computer size, speed and reliability improve.

Two, almost opposite, schools of thought are promoting the first two types of computer control in the CPI. The first method is favored by those who feel that dynamic models of chemical processes cannot be scaled up from laboratory data. They feel that plant experimentation is required and that the computer itself should be assigned the task of directing such experimentation.

The second method is being promoted by those who deplore the time, expense and wasted product involved in plant-scale experimentation. These persons feel also that problems of scaleup have been overemphasized, that the use of laboratory data and theoretical methods will suffice to determine mathematical models of most types of full-scale apparatus.

These two schools of thought on the best method of computer control imply a difference in the closeness with which the computer must be tied to the process it controls. For the learning computer to adequately do its work, it must be tied directly to the process. The characteristics of any additional elements in the control loop might modify or obscure process characteristics, resulting in a faulty mathematical model.

The dynamic control computer, however, may be able to use conventional control loops extensively if a study of the theoretical model shows their capabilities and responses to be adequate. This system, therefore, may be cheaper than the learning system.

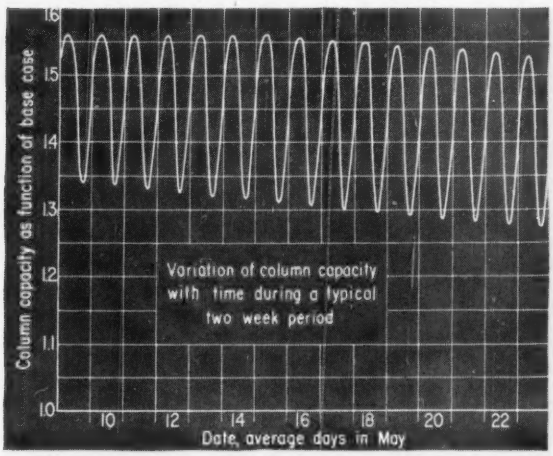
Which is better is only conjecture now, but the next few years should see some resolution of this question. Several organizations are hard at work studying one or both of the methods. My own feeling is that the second method is the correct approach.

While the above remarks have been fairly specific to use of digital computers for plant control, analog computers, particularly small special-purpose devices, hold promise for some control applications.[4-7] To date, these devices have all been designed for a specific job. They are equivalent in scope, complexity and application to a standard program controller that has added to it the facility to make limited calculations. With such facility, the machine can alter the program somewhat, both in magnitude and in time of application.

Applying Computer Control

The two different upsets imposed on the plant to produce product P are examples of upsets for which computer control is readily applied. This is particularly true where feedforward control is desirable. The

Column capacity varies with time.—Fig. 1



degree of control for each of the two upsets is considerably different, however.

Let's first see how computer control might aid us when we are faced with the cooling water variation shown in Figs. 1 and 2 of Part 6 (*Chem. Eng.*, June 27, 1960, p. 114). As shown by Fig. 1, on the next page, seasonal, and particularly diurnal, variations in coolant temperature have tremendous effect on maximum column capacity because the column, and hence the plant, is limited by the overhead condenser capacity.

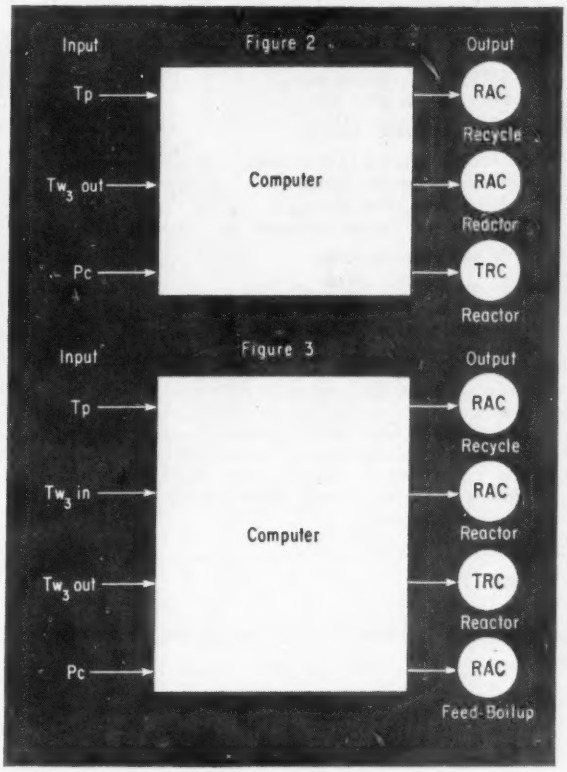
Presuming, for the moment, that the plant was being run for maximum output of P instead of the 40-million lb./yr. for which it was designed, let's discuss operations the computer must carry out to assure maximum throughput while still maintaining product quality specifications.

Fig. 2 indicates the task of the computer. It must sample product stream temperature T_p to assure that all product is being condensed. It must check product composition P_c to assure that specifications are still being met and that column entrainment, etc., has not become appreciable. Finally, it must find condenser water outlet temperature $T_{w_3,\ out}$ to assure that coolant flow isn't excessive.

With these data, the process equations of Table II are used to determine optimum ratio of reactant B to the available fixed amount of A, F_B/F_A. Too, they determine proper recycle ratio F_D/F_L and proper reactor temperature T_R. These three regulated output functions assure minimum cost for producing the desired amount of material.

If the third (interim) method of computer control is being used, i.e., steady-state calculations only, the computer must repetitively adjust and test throughout the operating period. This is because steady-state conditions must be attained in the system after a control change before accurate readings can be taken to calculate the next set of controller adjustments. External conditions change during the time required to attain

Computers optimize processing—Figs. 2, 3



equilibrium, however, so that full change in operating conditions cannot be made at any one time for fear of overshooting the equilibrium control point. The steady-state computer operates with considerable loss in efficiency in such a dynamic situation.

A computer that makes dynamic calculations can compute the system response to a contemplated change and make the maximum control change possible at any one time. It can also note trends, and from these can often anticipate future required control changes in feedforward control, rather than depend on feedback of the steady-state analysis.

Fig. 3 diagrams the control arrangement for the dynamic analysis computer. Inlet cooling water temperature $T_{w_3,\ in}$ is now needed to predict trends in the process variables. And for output, control of feed rate-boilup rate ratio F_H permits a feedforward anticipation function for column control.

Both Figs. 2 and 3 do not include all the other plant variables that must be monitored by the computer for check and alarm purposes. Those functions shown in the figures are for computing optima.

Fig. 4 compares the average gain possible, with both steady-state and dynamic computing, over conventional control methods. This assumes that conventional systems permit operators to follow seasonal coolant temperatures but not the diurnal variations in them. Table II shows the approximate capital costs that are allow-

Payout for computer control—Table II

Conventional control

Process produces profits of
$839,000/yr. before taxes
$402,720/yr. after taxes

Steady-state computer control

Process can produce 0.17 times more than with conventional control for incremental profits of
$68,460/yr. after taxes
With five-year payout, computer can cost $342,300

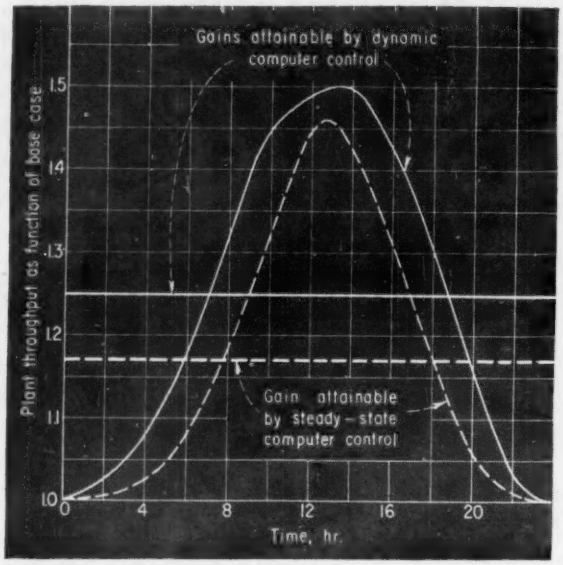
Dynamic computer control

Process can produce 0.25 times more than with conventional control for incremental profits of
$100,680/yr. after taxes

With five-year payout, computer can cost $503,400

(Following assumptions are made for above costing: additional production can be sold for such a price that return per unit of production remains constant, i.e., possible lower sales price is counterbalanced by lower production costs. Prices quoted are for installed costs of machines. Computers can be maintained without seriously interfering with plant operation.)

Computer control improves output—Fig. 4



able to install either type of computer control in the plant.

Short-Duration Upsets

Flow rate variations in reactant *A* provide the type of process upset that we classify as short-duration, in contrast with long-duration upsets imposed on this process by the cooling-water temperature variations. Either the steady-state or the dynamic-analysis computer can control long-term upsets, but only the latter is suitable for short-term disturbances. With a steady-state computer, therefore, a complete conventional control system is needed to compensate for these short-term variations. The computer then maintains the economic optimum called for by long-term variable fluctuations.

In terms of variations in flow rate at reactant *A*, the control computer effectively takes the place of the reactor-feed surge tank and its associated instrumentation. This is done by adjusting flows of reactant *B*, of steam and of coolant to maintain optimum reactor production despite fluctuations in flow of *A*.

Obviously, this part of the computer's task must be justified on the basis of replacing the equipment it is superseding. It's doubtful, though, that a computer for controlling the temperature excursions in the reactor could be capitalized as cheaply as the tank and instrumentation.

Analog Control Computers

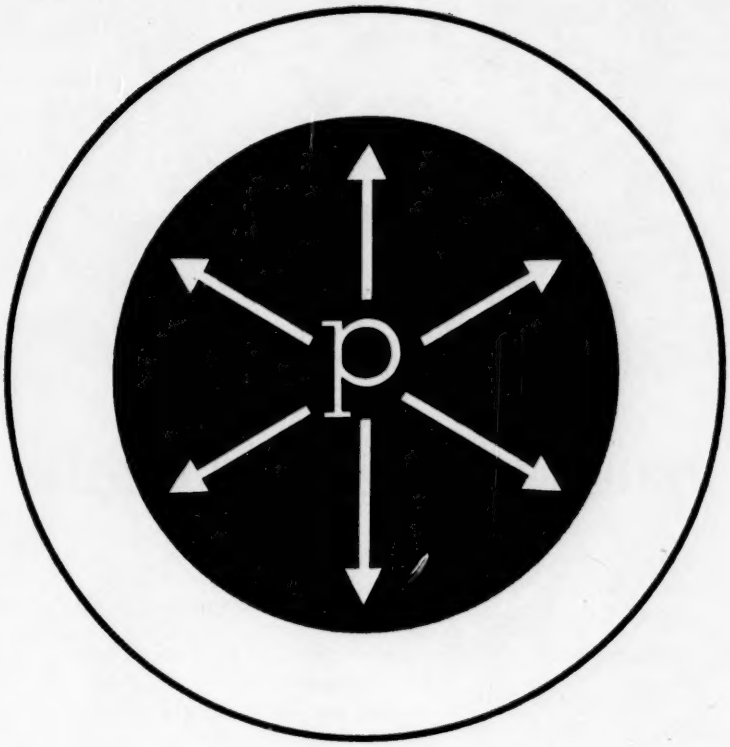
When physical relationships can be worked out ahead of time, and the computations required are fairly simple, analog computer control elements can be quite effective. For example, if we had only the daily variation in cooling water temperature to cope with and not the seasonal one, an extension one-time computing program could be run to determine the best settings of all other control components as the cooling water temperature varied.

An analog program could then be devised, and the corresponding special-purpose computer built, for a very reasonable sum compared with the cost of a digital control computer. This should give quite satisfactory control of such a process. But seasonal variation imposes a data requirement for the computer that seems unobtainable at a reasonable cost, if at all.

An analog computer could also be readily devised to compensate for variations in flow of reactant *A*. There is again grave doubt, however, that it could be made to pay when compared with cost of the surge tank plus related instrumentation. Such a device, too, would be difficult to coordinate with large-scale digital treatment of the coolant temperature variation. Nonetheless, the special analog computer controller field may be very active in the next several years, especially if a set of standard components can be developed.

References

1. Schall, W. C., In Big Computer Test, Plant Raises NH_3 Output, *Chem. Eng.*, Nov. 14, 1960, pp. 110-114.
2. Kalman, R. E., Lapidus, L., Shapiro, E., "Proceedings of a Joint Symposium on Instrumentation and Computation in Process Development and Plant Design," pp. B2-B13, Inst. Chem. Eng., London, 1959.
3. Stout, T. M., *IRE Trans. on Automatic Control*, PGAC-3, 3-7 (1957).
4. Fink, J. F., *Pet. Refiner*, Mar. 1959, pp. 215-220.
5. Lupfer, D. E., Berger, D. E., *ISA J*, June 1959, pp 34-39.
6. Tolin, E. D., Fluegel, D. A., paper at St. Paul meeting of AIChE, Sept. 1959.
7. Archer, D. H., *Brit. Chem. Eng.*, Feb. 1960, pp. 88-94.



Metallurgical Phenomena... and the metals to cope with them.

These are the stock-in-trade of the Lukens Application Engineer—whether the problem be one of pressure (symbolized above) or corrosion or abrasive impact or structural stress or high and low temperature. Investigation of the best steels for "problem" applications has been carried on for years by the Lukens Application Research team. We would welcome the opportunity to contribute the results of this research to your own design knowledge. Please contact us in your early design stages. Call collect: John D. Heffernan, Manager of Application Engineering, Extension 422, Lukens Steel Company, Coatesville, Pennsylvania. Or write: H-21 Services Building.

"VISIT OUR BOOTH AT THE AIChE EXPOSITION FEBRUARY 26-MARCH 1 IN NEW ORLEANS"

The Men in the Middle

The nonmilitant, but vocal, sounding-board organization argues that employed engineers and scientists want

- **Greater voice in company policies affecting their private lives.**
- **Increased participation in decisions affecting their technical careers.**

R. R. STOKES
Bell Telephone Laboratories

The sounding-board organization for furthering professional interests in an industrial corporation operates on a principle of adequacy. There should be no more organization than is necessary to respond adequately to demands of the employment situation.

Those who work under uncompromising managements need every sinew of strength they can command to maintain balance, but those who work under "answerable" managements require no organization. Sheer magnitude of size of the modern corporation, however, complicates management of the professional man, and it is generally he—not the manager—who first feels the effect of such complications.

Many professionals believe that the sounding-board organization is justified as an agency to single out the complications, to articulate the employee's interests by direct but reserved means. The professional in a sounding-board group wishes to talk with management, not to demand of it. He wishes to advance with the company, not at the expense of it.

This loyal man is genuinely concerned for the company that employs him. That concern transcends mere acceptance and allegiance; not only is there responsibility for doing assigned work well, but also responsibility for helping the company attain the best possible technical and administrative position. This implies responsibility for critically evaluating existing conditions and, using discriminating means, bringing about better conditions.

Role of the Manager

Frank Abrams, former board chairman of Standard Oil (N. J.) has said: "The job of professional management is to conduct affairs of the enterprise so as to maintain an equitable and workable balance among claims of the various directly interested groups—stockholders, employees, customers and the public at large."

Now professional people don't expect management to behave altruistically. In a free employment market, there is nothing that an employer is obliged to do at the request of employees. Nor can humanitarian arguments justify jeopardizing profits. Where employment is not economically constrained, the employee is free to disapprove of policies by leaving the company.

But each of the "directly interested groups" significantly influences the company's growth and profits, and each needs to be considered astutely, as it stands to modify the profit picture. It would seem self-evident that professionals, who contribute so directly to a company's material welfare and technological position, are a primary factor in influencing profits.

Consider, however, the history of the past half-century. Industrial corporations, the principal employers of technical professionals, have experienced great economic growth. During the same period, self-employed professionals—physicians, lawyers and engineers—have also notably succeeded. Employed professionals, however, have neither been recognized nor compensated in proportion to their contributions to the economic advance.

"Forgot we even had that one"

That's a typical reaction of Gardner-Denver air compressor owners when they check on compressed air costs. But this heavy-duty compressor never forgets. It keeps delivering dependable air power—on a continuous basis. Write for Bulletin HAC-40.

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd.,
14 Curity Ave., Toronto 16, Ontario

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

"A sounding-board organization provides for professionals a verbal 'focal-point' at which conscientious opinions converge."

The disparity between employed and self-employed professionals suggests that the general corporate philosophy of professional compensation, recognition, registration, employment conditions, autonomy and social self-image cultivation has not been vigorous. It suggests, too, that corporate management has evaluated professionals to be a secondary factor among profit influences, and consequently corporate personnel policies are partly responsible for the slow devaluation of the engineering profession.

It is here that the sounding-board organization rises to protect the interest of the professional technical man. As long as engineers are hired principally by industrial corporations, the profession cannot rise above the manager's view of it. And as long as there is a discrepancy between the status of the technical professions and the value society places on their contributions, there exists a need that our sounding-board group assumes as a prime objective—promotion of the general welfare of the professional.

The manager's view of the professional technical man must be well-informed and foresighted. Somehow, if he hopes to attract outstanding students and retain ambitious employees, the needs of professionals for adequate compensation and recognition must be timely met, not just caught up to. The penalties of underestimating these needs are damming of the source of new talent, and acceleration of turnover of old talent.

Using the Sounding Board

The right to discuss is more important than the need to agree—so might read the basis for sounding-board activity. So that management may know what conditions are important to employees, members respond to existing conditions and policies, and they promote alternatives to such conditions. Topics selected for discussion, and conclusions reached, need not represent opinions of the majority of members, but any member may discuss freely and openly any issue concerning conditions of employment.

Again and again, one point appears—the need for "improved communications" with management. Without oversimplification, this means, I believe, that the professional man wants (1) greater voice in policies that affect his private life, and (2) increased participation in decisions that affect his technical career. Improved communications means improved conditions for expression of employees' opinions in matters that concern them, together with improved management receptivity to the opinions.

As companies grow, the number of employees and the variety of their needs, interests and ambitions grow. But the growth of companies has accelerated standardization of administrative practices. Although reducing employee practices to company policy cuts inequity and eases administration, the resulting inflexibility makes the company less able to assist the employee in achieving personal objectives for his total life planning.

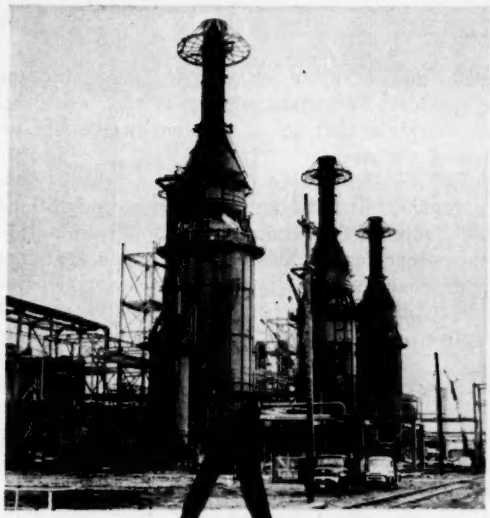
The goals and needs of one professional man differ considerably from those of his fellow. Where possible, and even at the expense of administrative ease and efficiency, company employment practices should be sufficiently flexible to permit the professional to better tailor the benefit structure to his personal objectives.

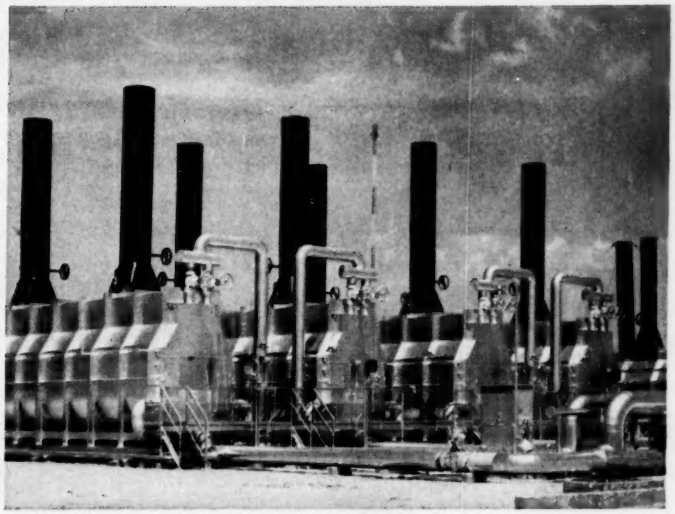
A company annually appropriates considerable money for fringe benefits, and how this money is used is determined by the management. Many employees, however, view fringe benefits as deferred pay, and scorn having others decide how it will be spent. They would like to have the right to indicate which benefits are more meaningful to them and to what extent each has significance in their private lives.

They would like to indicate, for example, how little one really needs a fourth week of vacation or whether to include a "spouse clause" in the pension plan. How much more realistic and satisfying it would be to permit the employee to select, from a financially limited but flexible benefit structure, those items that have the most significance to him. With more flexible company policy:

- An individual who anticipated greater than average retirement needs could elect to increase his return through participation in a vested or profit-sharing retirement program.
- An individual could save and carry over vacation days to suit his personal long-range plans.
- An individual might elect to accept those fringe benefits that are worthwhile to him and receive the equivalent cost of the other benefits in salary.
- An individual could participate in an open-ended stock purchase plan, subject to federal regulation, at those times that more conveniently accommodate his other financial plans.

Such a benefit structure, of course, implies that recipients are capable of estimating the extent of their real needs and are sufficiently responsible to provide them. But by controlling finge benefits, as is done now, the company increases stability of its workforce. For example, accumulated noncontributory pension benefits doubtlessly impose economic constraints that reduce employee mobility. It is just this tendency to place economic constraints on employees that concerns professional people who want more responsible control over their private lives.





100,000 to 200,000,000 BTU

PETROCHEM VERTICAL AND HORIZONTAL DIRECT FIRED HEATERS

For the petroleum, chemical and petrochemical industries, Yuba now offers the most complete series of direct-fired heaters available. From 100,000 to 200,000,000 BTU per hour – from -200° to +2,000° F – Petrochem Vertical and Horizontal Heaters can be built in every size and type for every use in any location!

Yuba Heaters are available from the most simple horizontal design to the famous Petrochem vertical with optional reradiation cones for even heat distribution and maximum efficiency.

Working closely with both customer and prime contractor, Yuba can provide single piece, shop-assembled horizontal heaters *to 30,000,000 BTU*. Other heaters up to 50,000,000 BTU can be provided in two sections. For field installations of larger heaters, Yuba can provide well-trained supervisory personnel when desired. Get the complete story on Petrochem direct-fired heaters from Yuba – your largest single, fully-integrated source of supply.

Other Yuba Products For The Petroleum, Chemical and Petrochemical Industries – Adsco Expansion Joints, Transaire Air-Cooled Heat Exchangers, Shell and Tube Heat Exchangers, Southwest Floating Roof Tanks, Cone Roof Tanks, Pressure Vessels, Field Erection, Columns and Towers, Process Condensers, Custom Fabrication.

YUBA

specialists in process heaters – every size, capacity and duty

YUBA TULSA CORPORATION
Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Chicago • Houston • Los Angeles • New York • Pittsburgh • San Francisco

"We are committed to the principle that among well-meaning people, a hearing can be obtained without stronger recourse than verbal persuasion."

Fully responsible working conditions, which adequately reflect value of the employee as technical contributor and as individual, have not been achieved as long as industry has not acknowledged that:

1. The individual has a primary interest in his own well-being.
2. No company has the right to make policies that progressively render the individual unable to act from free choice, due to economic constraints.
3. No company has a right to decide how any individual will spend any part of his earnings without his consent.
4. No company should have claim on a man unless he elects to remain employed due to attractiveness of the present conditions.

A Greater Voice in Technical Affairs

The engineer in industry today feels, too, that in addition to a voice in policies affecting his private life, he should also be personally identified with his company's activities. By intellectual capacity, training and contributions, he feels sufficiently qualified to have a voice in the functioning of the company. To be a party to and responsible for decisions being made imparts a sense of company identification that is a commendable, even indispensable, professional attitude.

But though everyone can't be a manager, the employee commonly finds he hasn't sufficient say in decisions affecting his technical activities and career. Subjected to seemingly remote forces that shape his future, he has little control over job assignments, transfers, quality of job support, attitude of supervision, project terminations or redirections, and personnel evaluations. What can be offered as a responsible alternative to this voicelessness?

First, greater influence in technical activities can be promoted by inviting employees to enter in the supervisory deliberations leading to decisions affecting the over-all project in which they're engaged. All too frequently, decisions that affect the course of a project are made by managers, based on information from intermediaries, without consulting the professionals who have worked on the project and who must carry it forward. Inviting employees to participate in project planning that affects their technical work not only stimulates identity, it also provides a broader base for developing qualified subordinates.

Second, greater voice in shaping his technical career can be promoted by inviting the employee to participate in the periodic evaluations of both his project and himself. There is a sense of achievement, of self-determination, in presenting one's case so that final evaluation may be made in light of factors the employee considers important. There is that assurance against oversight that permits a more wholesome acceptance of the results.

Beyond the point where the employee can be personally integrated into administrative considerations, as with project deliberation and personal evaluation, there are other factors affecting his career that intimately concern him. He is aware, for example, that his individual growth cannot exceed the structure for growth in which he works. So he questions that structure:

- Is the present organization an optimum structure designed around the particular needs of a professional staff and, if so, how does it differ from the structure found in nonprofessional work environments?
- Must an industrial organization with large numbers of professionals continue to be structured like a pyramid, or can the structure be modified to provide parallel paths of reward and recognition for technical and managerial personnel?
- Is the structure flexible enough to allow transfer withoupt prejudice, if an employee fails to realize his full potential in his assigned area?
- Are responsible personnel relations possible in a system where the employee, whose work is best known by his supervisor, cannot hold his supervisor accountable for his salary progression?
- Are service functions adequate to prevent perfunctory duties from impeding professional performance?

Improved communications would assure that employee opinions on these issues would be voiced by supervision to management. Ultimately, a sounding-board organization can do no more than convey opinions on matters like these. In response, management should appreciate the extent of this interest, making every effort to inform the employees of policy decisions and the basis for them.

As Clarence B. Randall recently wrote: "Communications suffer when management fails to sense that in a free society a man good enough to make a strong contribution is good enough to have his own scale of values. Only when an intelligent effort is made to

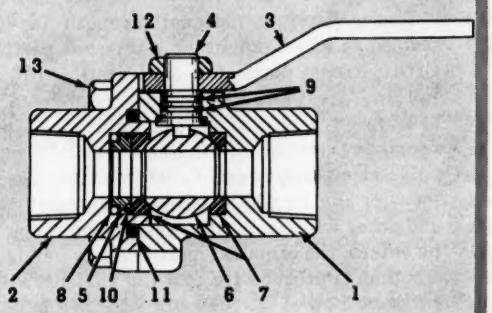
Meet the Author

R. R. STOKES *is a member of the technical staff of Bell Telephone Laboratories, Summit, N. J. A 30-year-old bachelor, Mr. Stokes received a B.M.E. from Clemson College in 1953. Shortly after joining the laboratories, he was called to the Air Force as a radar maintenance officer. Returning in 1955, he completed the Communications Development Training Course, a three-year program. Responsible in the area of electromechanical design, his latest accomplishment is design of the brand-new card-dialer telephone.*

NOW —*at last*— a low-cost, precision-built BALL VALVE!

R-P&C ANNOUNCES A NEW TRIUMPH IN MODERN VALVE TECHNOLOGY!

Made in sizes ½" to 2" inclusive



BODY (1) and **CAP** (2)—Forged Naval Bronze; **HANDLE** (3)—Malleable Iron; **STEM** (4), **DISC** (5) and **BALL** (6)—Naval Bronze; **SEAT** (7)—Buna "N"; **SPRING** (8)—Phosphor Bronze; **O-RINGS** (9,10,11)—Buna "N"; **NUT** (12)—Cadmium Plated; **SCREW** (13)—Carbon Steel

Take a good look at it!..

It's the ball valve you've been waiting for... the **R-P&C BL-300**... for dependable, trouble-free operation in water, oil and gas service. It is an entirely new concept in ball valve design—a combination of special features perfected with but one objective: *to provide you with a precision-built ball valve that costs no more than a high quality standard bronze gate valve.*

The **BL-300** has undergone hundreds of thousands of openings and closings without leakage or wear. It is fast and easy to operate, requiring only a quick quarter-turn of the handle to open and close, compared to several full turns needed to operate a gate or globe valve.

In every way the **BL-300** is truly outstanding... a triumph of modern valve technology. We invite you to view every precision detail of this new low-cost ball valve in a personal demonstration with your R-P&C distributor. Or, write us at Reading, Pa., and we will gladly send you descriptive **Folder DH-38** containing complete product information and specifications.

FEATURES...FEATURES...FEATURES

- The **BL-300** has "auto-mating" seats to assure positive sealing in either flow direction, making it ideal for vacuum service.
- Perfectly machined ball combines with auto-mating seats for smooth, positive valve operation.
- Wiping action of ball across seats prevents accumulation of foreign matter, eliminates maintenance.
- Buna "N" seats are impregnated with molybdenum disulphide—the modern lubricant—to give a slippery, non-galling surface.
- Two "O" ring stem seals assure a leak-proof stuffing box for the entire service life of the valve.
- Ball valve is rated for 300 psi—water, oil, gas; at 250°F maximum.

R-P&C VALVES

R-P&C Valve Division • American Chain & Cable Company, Inc.

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO

appreciate his objectives and to integrate them with those of the company do communications with him become a significant exercise."

A Question of Attitude

Individual worth in an industry is a relative measure, and to properly evaluate that worth, it is necessary to remain informed of conditions within the industry. Evaluation cannot be done in a vacuum. Distribution of information, i.e., defining current standards, is indispensable in promoting the welfare of technical people, and it forms the framework for all subsequent communications.

Some sounding-board groups, such as the Conference of Technical Professional Personnel at Bell Telephone Laboratories, have been active in providing comparative norms through newsletters and annual salary surveys, and in promoting improvements in the general employment structure. Appreciating the vigor of vested interests, we hold that it is better to overinform than underinform.

At the national level, however, sounding-board organizations have not had the influence for which they hoped. As a rule, managements have had reservations about such groups, have held back and observed them from a distance. This tendency toward noninterfering coexistence has, in many cases, prevented communication, leading to negative attitudes.

Not recognizing a sounding-board group within a company cannot be explained by Taft-Hartley prohibitions. A legal labor group must be certified by the NLRB, but sounding boards generally are prohibited from any affiliation, union or otherwise. Neither can lack of recognition be attributed to the understanding that undue management sanction would endanger the organization's autonomy. Rather, lack of recognition is felt by many managements to improve chances that the sounding-board group will dwindle and dissolve.

But when sounding-board effort is thwarted by nonrecognition, members' attitudes suffer. And injured attitudes promote a tendency to oppose actions that appear concessionary to managerial requests. Such a tendency is ill-afforded because the adoption of a reciprocal managerial attitude would nullify any chance of sounding-board influence. After prolonged effort has not elicited managerial response, those whose cynicism tends to fatalism question the adequacy of restrained sounding-board practices.

Managements are probably aware of the shortcomings in the continued existence of unrecognized sounding-board employee organizations. In the last analysis, the extent to which these shortcomings become manifest is an indication of the risk that management is willing to accept to maintain a policy of nonrecognition.

But so long as an attitude persists that questions the merits of employees participating in formulation of policies under which they work, sounding boards must persist. For sounding boards symbolize the professional employee's quest, by discriminate means, for greater voice as an individual.

Collective Action Takes Two Turns: One Union Dies, One May Be Born

The end of 1960 saw the collapse, at national level, of Engineers and Scientists of America. About the same time, AFL-CIO noted optimistically that existing industrial unions may make serious strides in the sixties toward organizing professional and other white-collar workers.

ESA, well-known to engineers through its recruiting efforts of the past eight years, collapsed for financial reasons, according to its president, Joe Amann. But the effect of financial weakness was to undermine the strength of number of members. The 1,800-member Assn. of Professional Engineering Personnel at RCA's Camden, N. J., plant voted disaffiliation with ESA following weak defense-fund support during a 1958 strike (*Chem. Eng.*, Oct. 6, 1958, pp. 156-158).

The dropping of the RCA group from national rolls, and the loss of the nearly 7,000-member Western Electric group in a decertification move last spring (*Chem. Eng.*, June 13, 1960, pp. 69, 71), were more than ESA could bear. Though a giant in engineering unionism, ESA estimated members at its demise at 17,000. Former affiliates now revert to local independent unions.

One thing's sure: both NSPE, arch-foe of engineering unions, and Amann agree that engineers must choose between unionism and professionalism. Says NSPE: "Collective bargaining for engineers is in conflict with the basic principles of a professional individual." Echoes Amann: "You can't ride two horses."

Organizers Still Optimistic

The setback to national strength in ESA hasn't seemed to affect spirits of interested parties at AFL-CIO. Strong plans for organization of white-collar workers are in the offing, bolstered by a beginning-of-the-year report from the Industrial Union Dept.'s research director, E. M. Kassalow.

Kassalow has urged formation of a special department or division to handle the approach to engineers and other white-collar workers at top union level. And, he opines, the chemical industry may be big as a target for that approach. He told *CE* that it's still too early to know how AFL-CIO will receive the recommendations in his report, but events of the past several years indicate that it will be cordial. As reported here two years ago (*Chem. Eng.*, July 13, 1959, p. 72), there has been considerable urgency within the big union to get white-collar organizing setup on a more effective basis.

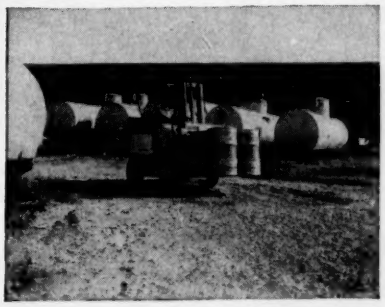
For example, James Carey, head of International Union of Electrical Workers, has been involved in the actions surrounding certification and decertification of the Engineers Assn. as IUE-affiliate at Sperry Gyroscope Co. This case, particularly, is being watched by AFL-CIO, and resolution may not be far off.

Yard materials handling your problem?

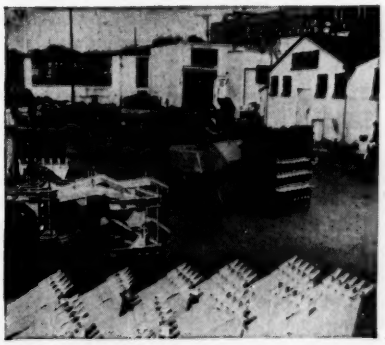
AUTOMATIC® gas-powered trucks cut fuel costs as much as 30%

Yard handling means long distances, semi-finished areas, ramps and all-weather operation. It can mean high fuel consumption, more maintenance. But it doesn't have to—not if you use the truck that's designed to cut fuel and maintenance costs. That's AUTOMATIC's pneumatic-tired Model GLFP, the gas-powered truck that saves up to 30% in fuel compared to similar trucks doing the same jobs. It saves on maintenance, too! Power steering is standard equipment. You get all this at the same price you would pay for less rugged equipment. Model GLFP is available in capacities of 3,000 thru 8,000 lbs. with pneumatic tires. Get all the facts. Mail coupon.

Precise inching control permits Model GLFP truck to accurately tier concrete block, bricks, lumber, and tile in minimum time.



Semi-finished area is no problem for the Model GLFP in this drum handling application. There's plenty of underclearance for outdoor work. Truck easily bridges the top of steep ramps.



Power steering as standard equipment makes the Model GLFP exceptionally maneuverable and easy to drive. Result: faster handling, lower costs.

AUTOMATIC

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
155 West 87th Street, Dept. B1, Chicago 20, Ill.

FIRST IN IMAGINATION
FIRST WITH REALITY

SEND FOR DESCRIPTIVE LITERATURE

New bulletin "Facts and Factors about Gas-powered Lift Trucks" and "AUTOMATIC Industrial Trucks Selector Guide" free on request.

Name_____

Company_____

Street_____

City_____ Zone____ State_____

Control Maintenance by Work Measurement

The nature of maintenance tasks makes effective study and control difficult, yet adequate means for measuring performance are as necessary in maintenance as they are in production.

HAROLD J. CHANDLER, *Ernst & Ernst*

Approximately 5¢ of every sales dollar is consumed by the increasing costs of plant maintenance that now exceed $14 billion annually. And as more and more factory processes are mechanized and higher speeds, temperatures and pressures are introduced, maintenance expenditures will increase still more rapidly.

Management is meeting the challenge by giving increased attention to better methods of maintenance cost control. These efforts are especially significant in the chemical and allied industries where maintenance costs represent a greater proportion of total plant costs than in other industries.

To effectively control and reduce maintenance costs, we may apply control methods that parallel those used in production operations. Work measurement applied to indirect labor, for instance, has not kept pace with the growth of measurement of direct labor activities.

Since the inception of scientific management, time-and-motion study and the use of standard data have been the basic tools for work measurement. More recently, work sampling, MTM and similar techniques have been developed and used for specific situations.

But since maintenance tasks are generally nonrepetitive in nature, they have received less attention from industrial engineers than have the more highly repetitive direct labor tasks.

The very nature of maintenance work requires an approach different from that to direct labor. We might even say that a different philosophy is required.

The maintenance control plan that we will describe is simple and quick to install, yet effective. Administrative costs are low. Several plants have realized savings of up to 30% after the installation of this program and it has been effective in plants with maintenance departments having from 25 to over 1,000 employees.

There are four fundamentals that must be incorporated in any maintenance control plan. They are:

1. You must develop a system of formalized work requests that includes reportage of time and materials used.
2. Activities of maintenance personnel must be scheduled and planned.
3. You must develop a means for measuring the over-all effectiveness of all your maintenance crews.
4. You must have a preventive maintenance program to maintain plant and equipment at lowest cost.

In addition to these fundamentals, there must also be a sound and functional maintenance organization existing and management and maintenance supervision must fully understand the program and endorse its principles.

This program reduces maintenance costs by providing a means for management to plan maintenance tasks to better advantage. It also provides a method for the evaluation of working efficiency of maintenance crews. The preventive maintenance program assures that plant maintenance costs will be maintained at minimum levels over a period of time.

The Work Order System

The basic requisite of this plan is that a formal work request shall be prepared by authorized personnel and approved by qualified executives.

A written work-order system provides: a record of requests for maintenance jobs; a record of the approval by qualified executives; a basis for the accumulation of time and materials required; and a means for developing costs consciousness on the part of maintenance foremen.

Size and format of the work-order is unimportant other than that it should provide space for pertinent data, such as:

- Dates of issuance, start and completion.
- Department or charge cost center.
- Machine or equipment number.
- Charge account number.
- Authorized approvals.
- Complete description of work required.

A multi-part, pre-numbered work order is generally used.

Work-orders may be originated by the requestor and then forwarded to the maintenance department after approval. Or all requests may be telephoned to the maintenance dispatcher who prepares and schedules individual tasks. Another plan, effective in large plants where maintenance functions are decentralized, me-

HERE'S ONE THAT WORKS ...

every time—and for a long time

You'll never break your back trying to turn this valve. The plug seals securely in a Teflon® sleeve. It won't stick or freeze—even after months in one position. It's priced to replace ball valves, gate valves and lubricated plug valves wherever they are in use.

Available in ¼" through 6", 150 and 300 psi, straightway and 3 way. Alloys include carbon steel, 316 S.S., Durimet-20, Monel, Nickel, Chlorimet-2 and Chlorimet-3.

Write for your copy of Bulletin V/14.

DURCO

Serves the Process Industries

THE DURIRON COMPANY, INC., Dayton, Ohio / Valves • Pumps • Filters • Process Equipment

It is cheaper to buy it—Table I

	Cost To make	To buy
Foreman's metal desk	$98.25	$28.50
100 steel washers	40.00	12.00
Stepladder	31.60	6.24
Draftsman's swivel tray	37.71	7.50

chanically records and later transcribes order communications.

One of the advantages of the work order system is that it may immediately reveal situations where uneconomical use is being made of maintenance personnel. Table I shows actual examples where a maintenance department was making items that could be purchased outside more economically.

Scheduling and Planning

Each day, work-orders should be selected in order of priority and a day's work should be planned for each worker. All major items should be projected on a planning sheet that shows the sequence of operations, the number of employees required and the sequence by crafts. Job progress should be followed daily and percent completion noted on the chart.

Estimates or other standards that you establish, as we will explain, should be used in determining man-hour requirements for the scheduling program.

You can schedule jobs far in advance when they fit in with shutdowns or with available dates predicted on production schedules. Priorities of smaller jobs will change from day to day, but the work load should be reviewed periodically so that corrective action may be taken before employees are overloaded or idle.

A work-load chart, such as that shown in Fig. 1, provides an effective method for review of the maintenance work load.

By referring to planning charts, the maintenance superintendent can:

1. Keep informed on over-all progress.
2. Direct his attention to jobs that are behind schedule.
3. See clearly what effect rush jobs have on those in progress and which jobs can be more conveniently delayed if necessary.
4. Keep operating personnel informed as to job status without requiring special field checks that are usually time consuming and often inaccurate.
5. Minimize overtime or week-end assignments.

Periodic meetings of maintenance department supervisors are necessary to the proper planning and scheduling of work. Portrayal of major jobs on a planning board placed in the maintenance office, so that status may be quickly ascertained, is a valuable aid in such meetings.

A combination of the following techniques is necessary to the establishment of work measurement standards in maintenance:

1. Past performance records.
2. Pre-established standards data.
3. Time study.
4. Work sampling.
5. Estimates by qualified personnel.

Work Standards

Setting standards requires first the establishment of statistical standards. We do this by collecting all orders for a base period of about six months, then segregate the orders by craft and work classifications as follows:

Routine: regularly scheduled jobs that need no work order and are usually performed by the same group of workers.

Repetitive: jobs that require maintenance work orders and repeat at least once a month.

Nonrepetitive: jobs performed on work orders that require less than 96 man-hours to perform.

Estimated: all maintenance work requiring more than 96 man-hours to perform.

Establish Statistical Standards

Statistics for routine jobs are accumulated for a period of about six months and statistical standards are then established as shown in Fig. 2.

As we said, routine jobs of this nature do not require written work orders. We assign a permanent routine identification number to each of these tasks and the maintenance employee reports time worked on

PLANNING AND SCHEDULING
WEEKLY WORK LOAD CHART
CRAFT – ELECTRICIANS WEEK ENDING 2/5/61

	Work On Hand Beginning Of Week		Completed This Week		Received This Week		Work Ahead	
Type Of Work	Orders	Hours	Orders	Hours	Orders	Hours	Orders	Hours
Routine		200		200		200		200
Repairs	40	1,440	50	1,395	48	1,445	38	1,490
Construction	3	805	2	750	4	910	5	965
Total	43	2,445	52	2,345	52	2,555	43	2,655
Available Hours	15 MEN x 40 HOURS = 600							
Weeks Of Work Ahead	2,655/600 = 4.4 WEEKS							

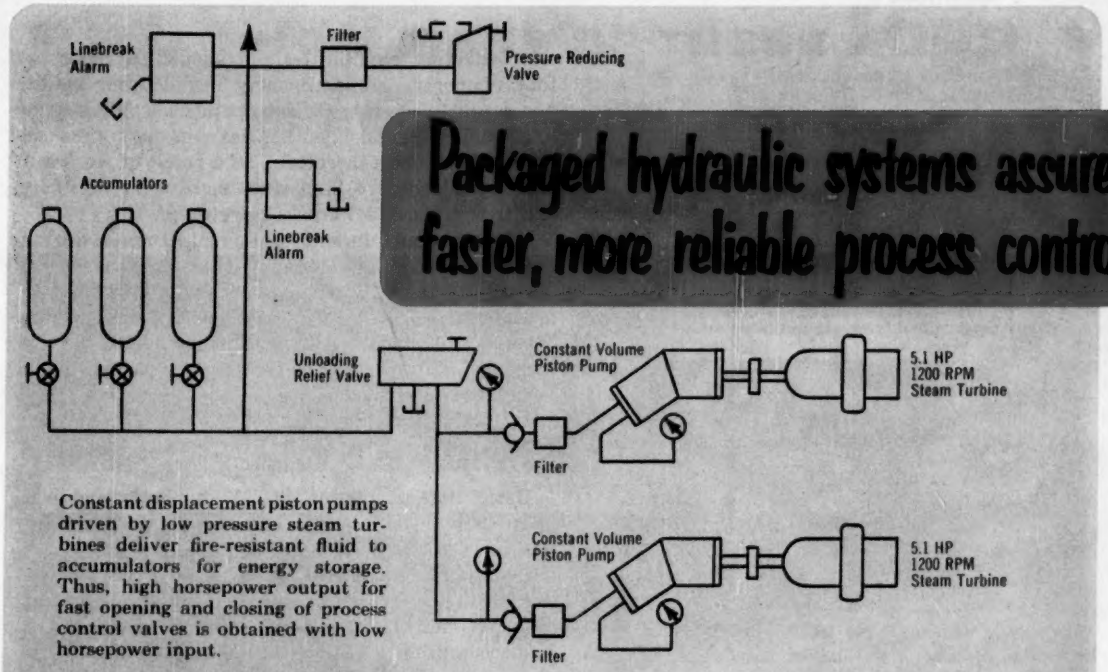
Work-load chart helps maintenance department keep track of work on hand, done and newly received.—(Fig. 1)

EARNED HOUR STANDARDS - BASE PERIOD
ELECTRICAL SHOP

Routine Jobs	Days, Weeks Or Units	Actual Hours	Earned Hour Standards
Oil Motors - Route A	127	1,714.5	13.5 PER DAY
Oil Motors - Route B	127	1,016.0	8.0 PER DAY
Oil Motors - Route C	127	317.5	2.5 PER DAY
Replace light bulbs	508	254.0	.5 PER UNIT
Check cranes	26	104.0	4.0 PER WEEK
Check elevators	26	67.6	2.6 PER WEEK
Clean shop	26	20.8	.8 PER WEEK

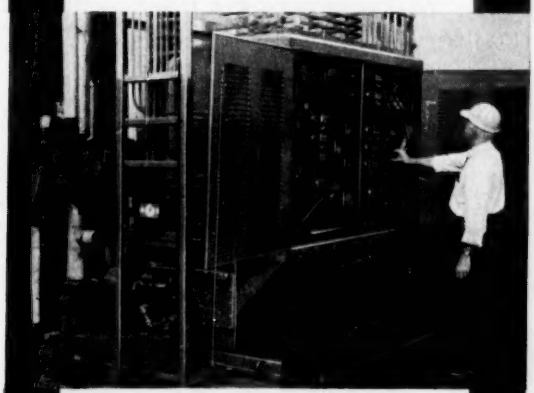
Data collected on routine jobs over a definite time period yield standard time information for each job that permits accurate maintenance cost accounting and control.—(Fig. 2)

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

VICKERS INCORPORATED
DIVISION SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1400 • Detroit 32, Michigan

9138

EARNED HOUR STANDARDS - BASE PERIOD
PIPE FITTINGS

Repetitive Jobs	Code	Number of Orders	Actual Hours	Earned Hours Standard
Air lines - check pressure	R1	51	71.6	1.4
Drains - clean out - open	R2	32	51.9	2.6
Drinking fountain - check, repair	R3	18	21.7	1.2
Fire extinguisher - fill, change	R4	24	62.4	2.6
Hose - install, repair	R5	55	82.1	1.5
Leaks, water - repair	R6	131	301.3	2.3
Pump - pack	R7	46	95.9	2.0
Screen - clean, change	R8	17	165.8	9.7
Valves - install - up to 3"	R9	30	60.2	2.0

Frequency and cost of different small repetitive pipe-fitting jobs are easily determined from accumulated data.—(Fig. 3)

EARNED HOUR STANDARDS - BASE PERIOD
PIPE FITTERS
NONREPETITIVE JOBS

Code	Group	Number Of Jobs	Actual Hours	Average Hours Per Job
A	Up to 4 hours	125	237.6	1.9
B	Over 4 to 8 hours	88	536.8	6.1
C	Over 8 to 16 hours	79	873.4	11.6
D	Over 16 to 32 hours	16	356.2	22.2
E	Over 32 to 48 hours	9	345.6	38.4
F	Over 48 to 96 hours	6	387.2	64.5
	Total	323	2,736.3	

Classification of non-repetitive jobs according to the time required to do them helps to establish standards.—(Fig. 4)

the particular job number rather than a work order.

Repetitive job orders are sorted by craft and job classification for the base period of six months and the average time per job becomes the standard. Fig. 3 illustrates the establishment of repetitive standards for the pipefitting craft.

We determine the standard by dividing the total actual hours charged to a specific job by the number of orders. Later, we will describe the method for adjusting the statistical standards to more realistic work measurement standards.

All work orders not of a repetitive nature and requiring less than 96 man-hours are considered nonrepetitive or miscellaneous jobs and are segregated by time classification for establishing standards.

Time classifications are: up to 4 hr., over 4 to 8 hr., over 8 to 16 hr., over 16 to 32 hr., over 32 to 48 hr. and over 48 to 96 hr. All orders completed during the base period are sorted by craft and by time classification and the average time per job is computed. This average then becomes the statistical standard. Fig. 4 shows an example of this procedure for pipefitters.

In the case of repetitive and nonrepetitive jobs, the work administrator or estimator places the code identification on the work-order prior to the start of the job, except for those few that might require further investigation before the start of the work. In other words, all work of this nature is preclassified prior to the start of the job.

All jobs expected to require more than 96 man-hours are estimated by a qualified estimator to obtain maximum control of all maintenance hours. To assist in this phase of the program, standard data are prepared from studies, published books and articles, or by other means.

Statistical standards, once established, usually reveal cost reduction possibilities. It should be recognized that temporary standards may include poor maintenance practices or inefficient operations. Work sampling studies reveal inefficiencies and lost time and expose the reasons therefore. As a result of work sampling standards are levelled to more realistic figures and true craft effectiveness is revealed.

You can apply incentives to maintenance work to secure added cooperation of the maintenance employees, particularly where there is incentive pay for production workers. The productivity measurement features of the plan we have outlined will enable a company to institute a means for sharing cost reductions with its maintenance people.

Standards Hard to Apply

Basic time standards, MTM standards and other scientific time data have been adopted by many plants, but their use is limited in maintenance.

Basic time standards can be established for tasks such as painting and some pipefitting operations. However, millwright work, tinsmith work, etc., present numerous problems that make the application of synthetic time standards questionable when the administrative costs are considered.

Any plant considering a work measurement program should first apply the methods outlined here. In the average plant, statistical standards may be established in six months or less so that some cost improvements may be realized in a relatively short time. Then standards may be further refined with time study, work sampling, MTM or basic time standards depending on circumstances or practicability.

In any case, maintenance is universally in need of study, improvement and cost control techniques.

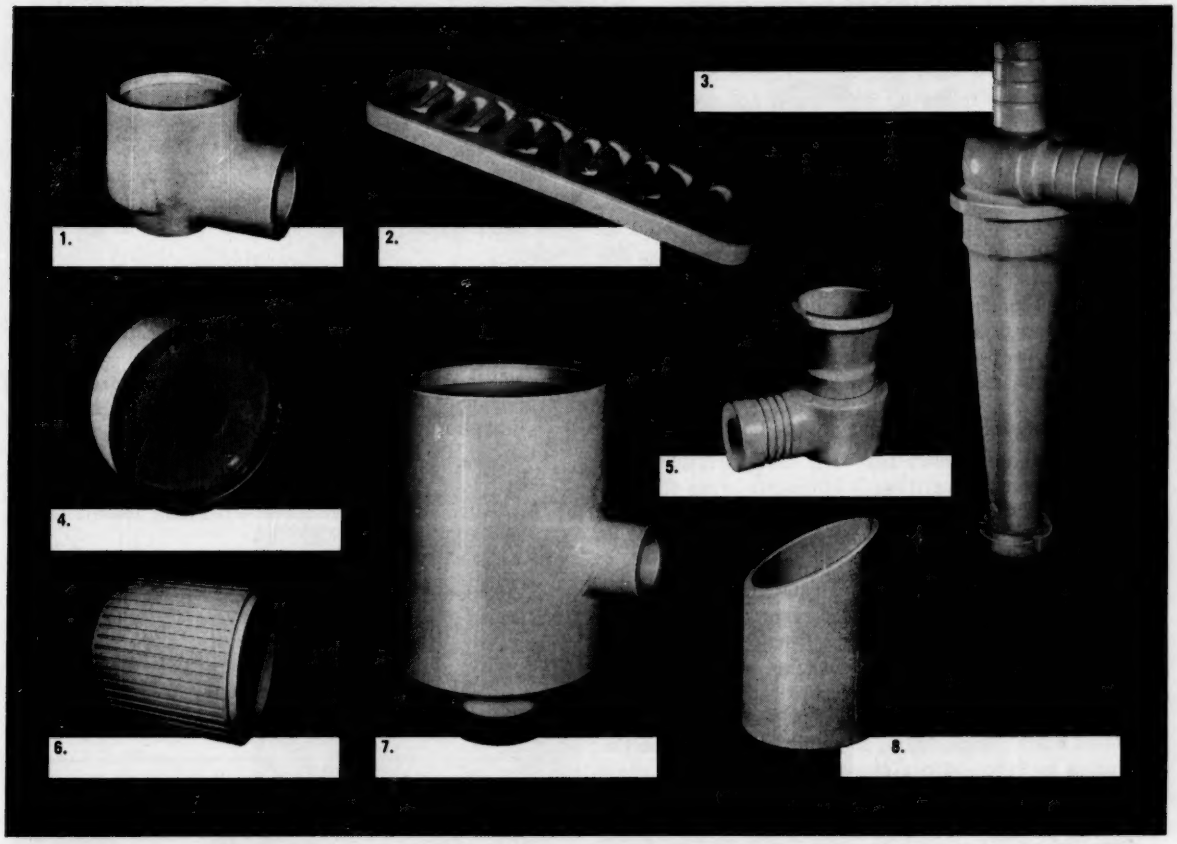
Weekly reports that reveal craft performance are issued to management and maintenance executives.

WEEKLY EARNED HOUR CONTROL REPORT
MAINTENANCE DIVISION **WEEK ENDING 2/5/61**

Craft	Classification Of Jobs	Ten Week Moving Average Earned Hours	Actual Hours	Per Cent
Electricians	Routine	128	173	74
	Repetitive	206	284	71
	Nonrepetitive	201	275	73
	Estimated	318	442	72
	Total	853	1,174	73
Pipe fitters	Routine	141	210	67
	Repetitive	416	585	72
	Nonrepetitive	309	468	66
	Estimated	354	492	72
	Total	1,284	1,855	69
Machinists	Routine	130	178	73
	Repetitive	106	143	74
	Nonrepetitive	84	119	71
	Estimated	204	276	74
	Total	524	716	73
Total Maintenance Division	Routine	1,202	1,769	68
	Repetitive	1,125	1,584	71
	Nonrepetitive	918	1,330	69
	Estimated	1,458	2,025	72
	Total	4,703	6,706	70

Weekly summary reports for all crafts and job classifications show quickly how controls are working.—(Fig. 5)

HOW MANY OF THESE Lapp "SPECIAL SHAPE" PORCELAINS CAN YOU IDENTIFY?



Probably not too many. That's because these are all custom-made porcelains, produced for specialized needs.

Lapp Chemical Porcelain in customized shapes has solved thousands of problems where acid and/or abrasion-resistant surfaces are required.

Other important considerations are the low cost of raw materials (especially when compared with high alloys), the advantageous physical properties of Lapp porcelain (hardness, density, zero absorption, uniformity).

Custom-made porcelain can solve your problem and save you money. Ask us. Special shapes get special attention here at Lapp.

ANSWERS: 1. Steam ejector entraining chamber; 2. Paper maker's felt conditioner plate; 3. Cyclone Classifier; 4. Godet wheel for rayon filaments; 5. Funnel cock for etching machine; 6. Roll for rayon processing; 7. Condenser chamber; 8. Outlet liner for brick line tower.

Lapp

WRITE *for description and specifications of Lapp Chemical Porcelain. Lapp Insulator Co. Inc., Process Equipment Division, 1914 Poplar St., LeRoy, N. Y.*

Fig. 5 illustrates an example of a weekly report after standards have been levelled through the use of work sampling techniques.

An effective program of planned maintenance requires periodic inspection of property, machinery and equipment so that anticipated breakdowns, repairs or overhauls can be performed on a planned basis.

Preventive Maintenance

Basically, the following procedures are necessary to install a preventive maintenance plan:

1. All machinery and equipment should be numbered for identification.
2. Equipment record cards should be compiled.
3. Routine inspection and oiling routes should be determined and clearly defined on master cards as follows:
   a. Equipment to be oiled, type of lubricant and number and type of fittings.
   b. Inspection requirements: intense, medium or minor. Amount of minor repairs performed at this time.
   c. Periodic trips: daily, weekly, monthly, etc.
   d. Standard hours for each routine trip.
4. Equipment record cards of certain types of equipment should be kept in an open file as should cards of equipment requiring attention. Each card should indicate the date of attention.
5. Maintenance employees should be supplied with master work sheets or tabulated reports on which completed jobs should be indicated. Employees should also itemize requests for repair work as noted during inspection. Work orders should then be issued.
6. The control plan reveals repair costs of all jobs. Actual costs are posted to the equipment cards so that repairs by types of equipment are known, thus enabling the plant engineer to determine if routine inspection and oiling are necessary, if major repairs are required or if it would be more economical to replace the equipment.

At the start of the preventive maintenance program, take care that the details and clerical work are not excessive and that the maintenance groups are qualified to perform preventive maintenance functions. Only the most critical equipment should be included in the program in the beginning; additional equipment may be added as conditions warrant.

Keep Track of Stores

Maintenance spare parts and materials are important cost items. Having proper materials available when needed and keeping the inventory investment within reasonable amounts are objectives to be constantly pursued.

Good storekeeping practices such as are normal for production stores are also applicable to maintenance stores. It is important to:

1. Examine stores layout to assure minimum travel.
2. Keep storeroom safeguarded by assigning attendants and/or by locked enclosure with control of materials withdrawn.
3. Review usage periodically and established maximum and minimum levels for each item.
4. Provide sufficient stores personnel to service mechanics with minimum delay.
5. Provide scheduled delivery service, particularly in large plants.
6. Segregate and identify material purchased for special jobs.
7. Maintain adequate stores records. Consider carefully when items should be manufactured and when they should be purchased.

When materials are issued by stores to mechanics, the costs are charged to the work order number of the job and the total material costs are posted to the work order.

If tabulating equipment is available, inventory controls and material job cost information may be determined quite readily with a minimum of clerical effort.

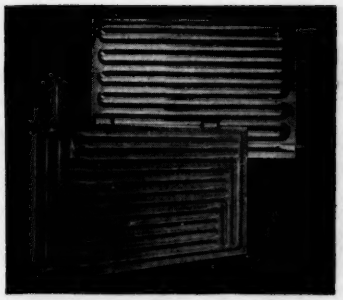
The techniques illustrated here can:

- Provide a plan for preventive maintenance.
- Give you a practical work-measurement program.
- Provide incentives, if so desired.
- Yield a practical scheduling and maintenance program.
- Provide a method for determining maintenance workload.
- Provide a plan for preventive maintenance.
- Provide a spare parts and inventory cost control plan.
- Yield low administrative costs.
- Give you improved maintenance at reduced costs.

Meet the Author

HAROLD J. CHANDLER *has broad experience in developing and applying modern techniques of management. A mechanical engineer, he acquired solid in-plant experience as time study engineer and chief industrial engineer before joining Ernst & Ernst with whom he has now been associated some twenty-five years. He is now District Supervisor of Management Services at Cleveland, Ohio.*

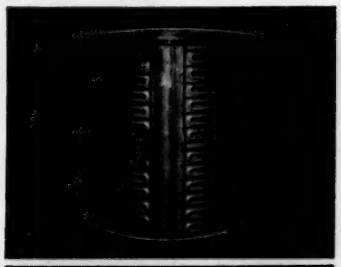
Mr. Chandler is an active member of AMA, AIIE, Cleveland Engineering Society and the Cleveland Chamber of Commerce. He is a frequent lecturer at seminars and clinics sponsored by various universities, the AMA, AIIE and MTM Association.

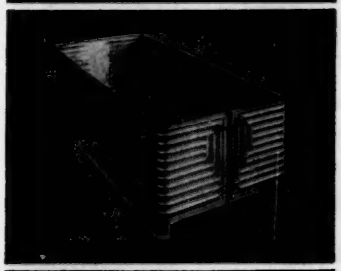


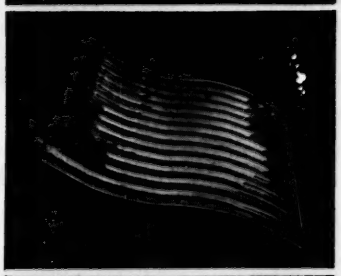
PLATECOIL®

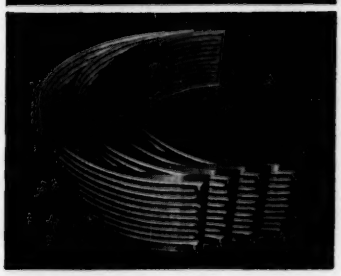
"STANDARD" STYLES OR SPECIALLY FORMED AND FABRICATED

=a SOLUTION









TO DIFFICULT HEAT TRANSFER PROBLEMS

Now you can apply the engineering, installation, operational and maintenance advantages of PLATECOIL to more tank and process heating and cooling problems than ever before. Standard units with exclusive "MULTI-ZONE" pass design for faster heat-up and temperature recovery or serpentine pass arrangement satisfy many requirements. These "standard" styles, available in a wide variety of sizes can be factory-fabricated into banks to fit the application. PLATECOIL can be formed and rolled to specified diameters or even fabricated to form tank walls.

PLATECOIL provides a "packaged" answer to many heat transfer problems, avoiding costly engineering and fabricating of pipe coils. Units are easy to install and maintain—with simple connections, light weight, and streamlined surfaces. High heat transfer capacity permits compact, space-saving units.

Both "standard" and specially built PLATECOIL are available in mild steel, stainless steel, Inconel, Monel, Ni-O-nel, Hastelloy B, C and F, Nickel and other weldable materials. Operating pressures up to 250 psig. Safety factor—5 to 1. Double embossed or one side flat. Complete engineering data and assistance available.

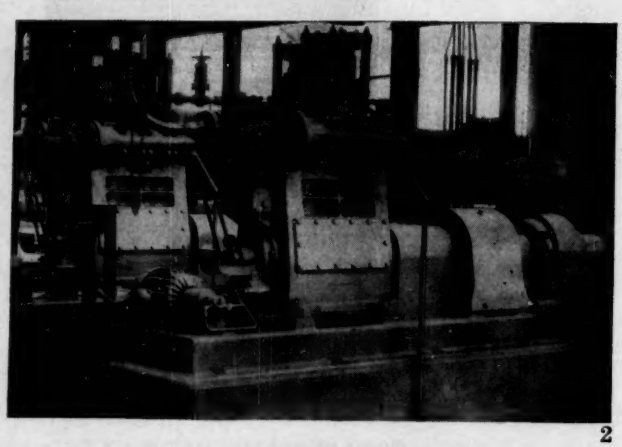
Ask for Bulletin P61.

tranter Manufacturing, inc.

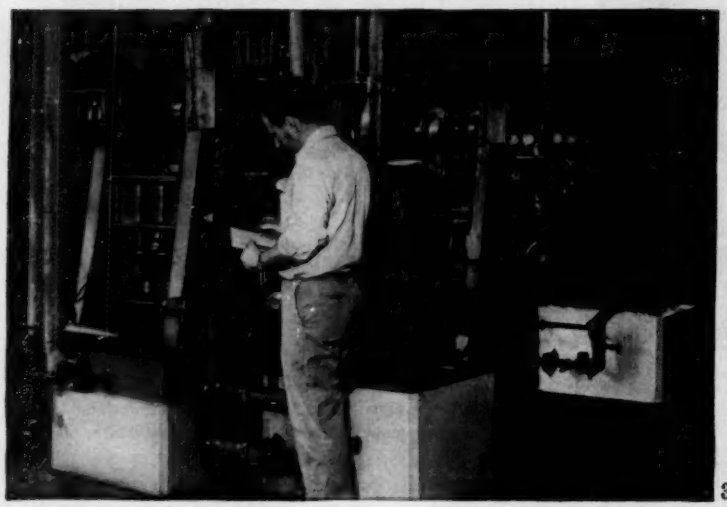
LANSING 9, MICHIGAN

PLATECOIL® DIVISION

1



2



3

4

ABRASIVE... CORROSIVE... HIGHLY COMPRESSIBLE... VISCOUS...

which type of flow is giving you pump trouble?

If your pressures are high . . .

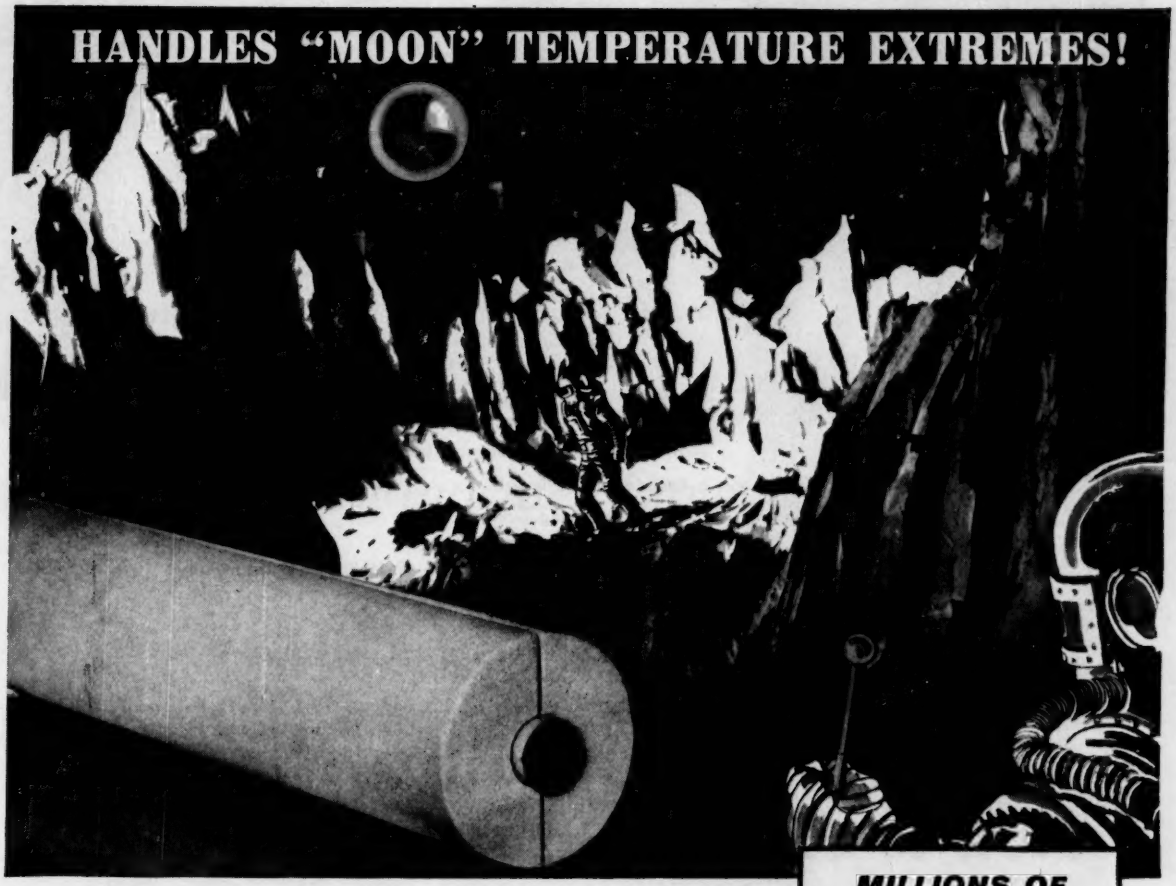
If a corrosive, abrasive, viscous or highly compressible liquid is giving your pumps a hard time . . . Aldrich can answer your problem! We *specialize* in pumps for hard-to-handle liquids in the chemical industry . . . working with the widest range of special fluid-end materials and designs in the industry today.

For example: in installation #1 above, an Aldrich pump with stainless steel fluid-ends and special nylon ball valves eliminated severe maintenance problems in handling silica gel at 1800 psi. In installation #2, fluid-ends of 3½% nickel steel have been handling a 50% caustic soda solution continuously for over two years. The reliability record has been perfect. In installation #3, a special Aldrich pump with stainless steel fluid-end has given 8 years of uninterrupted service handling a hot resin ester at 6000 psi. In installation #4, Aldrich pumps with stainless steel fluid-ends have served continuously for over 12 years, pumping hot, corrosive, fatty acids.

Aldrich Pumps range from 25 to 2500 hp.; pressures to 50,000 psi. For additional information, see our insert in *Chemical Engineering Catalog*. For complete data, or help on a specific problem, write Aldrich Pump Company, 3 Gordon Street, Allentown, Penna.

THE TOUGH PUMPING PROBLEMS GO TO ALDRICH

HANDLES "MOON" TEMPERATURE EXTREMES!



New low temperature insulation handles jobs in − 300° F. to + 220° F. range

Of course, this new Unarco U200 insulation is not in use on the moon . . . but it could be, because it handles temperature extremes even greater than would be required on this bleak island in space.* What's more U200 does it without thermal shock effects anywhere along the line.

A new, extremely lightweight, closed cell synthetic, U200 has excellent heat and chemical resistance. Its K factor is only 0.14 at 70° F. mean temperature . . . lowest on the market. Density is only 2.3 lb. per cubic foot. Yet this remarkable, new material has high compressive and flexural strength. It's non-toxic and easy to handle, too.

Try it just once and you'll see how quickly and easily it can be cut and applied with a very minimum of standard hand tools. It can actually reduce application costs by as much as 50%.

Available in accurate, half-round sections; in nominal thicknesses and in standard pipe sizes. Individual sections 36 inches long. Also available in 12" x 36" block form—1" to 5" thickness in ½" increments.

(*) *−243° F. to +214° F. Estimated moon temperatures as listed in a leading American encyclopedia.*

Get complete engineering specifications and other details before another day goes by.

Write today on your company letterhead for Unarco Bulletin No. U200-1.

MILLIONS OF CLOSED CELLS MAKE U-200

- **Waterproof**
- **Vapor Resistant**
- **Efficient**
- **Lightweight**
- **Easy to Handle**

*Closed cell content of 85% plus.

U-200 *The insulation with "Handleability"*

POLYURETHANE FOAM

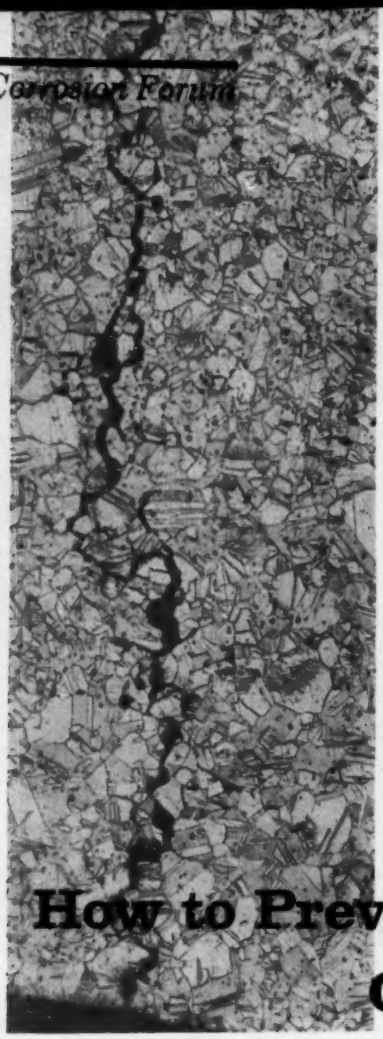
UNARCO ®

UNARCO PRODUCTS

• UNIBESTOS, Amosite Asbestos Pipe Covering and Block • Calcium Silicate Pipe Covering and Block • 85% Magnesia Pipe Covering and Block • Mineral Fiber Block • Wrap-On Insulation • Lace-On Insulation • Turbine Blankets • Insulating and Finishing Cements • Asbestos Textiles • Packing and Gasketing.

UNION ASBESTOS & RUBBER COMPANY

Fibrous Products Division • **Dept. 294, Bloomington, Illinois.**



◀ **Catastrophic** stress-corrosion cracking in a leaded brass tube.

Three important ways to keep copper alloys from cracking

1. Get rid of stress by . . .
   - Annealing.
   - Relief annealing (metal is not softened).
   - Mechanical surface treatment (shot peening to put metal surface in compression).
2. Exclude corrodents with . . .
   - Protective coating.
   - Modification of environment.
   - Control of storage conditions to eliminate condensing moisture.
3. Change alloy to one . . .
   - Containing less zinc.
   - That is stronger (cold roll alloy to increase strength).

How to Prevent Stress-Corrosion Cracking of Copper Alloys

DAVID H. THOMPSON, *Anaconda American Brass Co.*

Some years ago a foreman in one of the brass mills of the Naugatuck valley gazed with extreme displeasure at the brass rod he held in his hand. He had watched as this rod was produced; it was sound, dense, strong. The next day that same rod was shattered by cracks; it was a handful of metal splinters and broken shards. This was his introduction to season or stress-corrosion cracking, a long-time enemy of copper alloys.

Now, many years later, we know what causes season cracking and many instances of such cracking are completely avoidable. This, in the face of vast amounts of theoretical work on the subject which has not achieved a completely satisfactory description of the mechanism of the phenomenon.

▶ **What Is It?**—Season cracking is the specific name given to stress-corrosion cracking of brass. It is a sudden, spontaneous, catastrophic, brittle fracture of metal caused by the simultaneous action of a corrodent and stress. In the early days of metallurgy, it was thought that season cracking was a serious shortcoming of brass only. But in time it became known that not only brass, but nearly all copper alloys, were subject to stress-corrosion cracking. Fortunately for the brass industry, but unfortunately for others, it subsequently appeared that nearly all alloys (pure metals are generally exceptions) are subject to stress-corrosion cracking under certain circumstances. In some cases the practical importance is great, the possibility of loss (economic or otherwise) enormous.

▶ **Causes and Cures**—Several factors must operate together to cause stress-corrosion cracking. One of major importance is, of course, stress. This stress must be tensile (to pull the metal apart). Usually it is a residual stress from some prior cold deformation such as deep drawing or spinning. Applied stress —the stress resulting from application of a load—less frequently causes stress-corrosion cracking because such stress is usually under the control of a design engineer.

The corrodent that causes stress-corrosion cracking is likely to be

Fluorine and Fluorides Causing Corrosion?

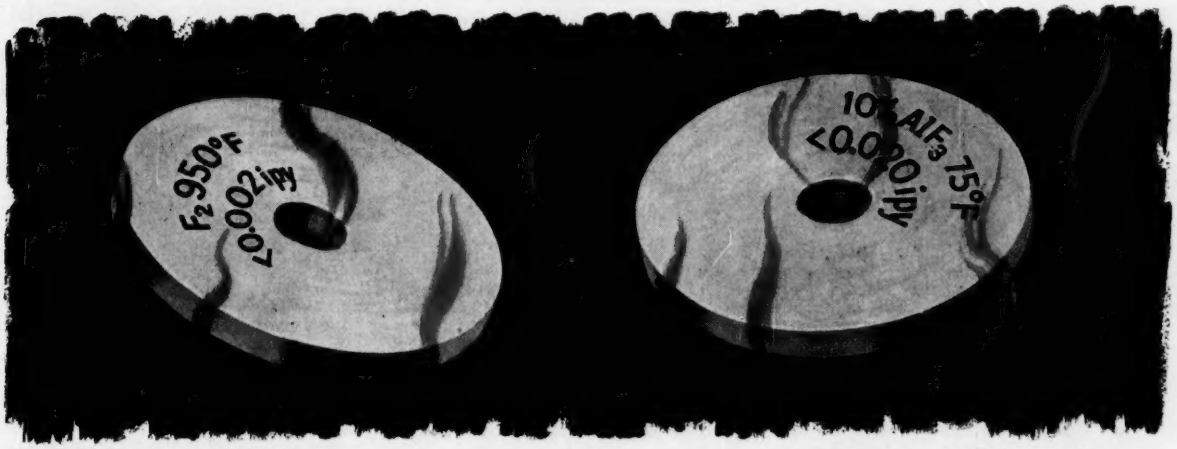
...Test **HAYNES** Alloys

Ability to withstand the "bite" of fluorine and fluorides is a quality possessed by few metals. HASTELLOY alloy C has this ability.

Alloy C is resistant to fluorine gas as hot as 950 deg. F, and it is so impervious to HF gas it can be utilized in the production of hydrofluoric acid. The remarkably low penetration rates shown on the test samples in the illustration indicate the extraordinary resistance of alloy C to this family of corrodents.

HASTELLOY alloy C is one of 9 HAYNES corrosion-resistant alloys developed over a 30-year span of intensive research on corrosion problems and metals that resist them. You can capitalize on the results of this 30-year research program.

Send for test samples. Write us a letter outlining your corrosion problem. We will send you free test samples of the alloy best suited to solve it. Address your letter to Haynes Stellite Company, 270 Park Avenue, New York 17, N. Y.



HAYNES
ALLOYS
HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

"Haynes," "Hastelloy," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

How copper alloys rate in resisting stress-corrosion cracking

Low resistance

- Brass containing over 20% zinc.
- Brass containing over 20% zinc and small amounts of lead, tin, or aluminum such as leaded high brass, naval brass, admiralty and aluminum brass.

Intermediate resistance

- Brasses containing less than 20% zinc, such as red brass, commercial bronze, and gilding.
- Aluminum bronze.
- Nickel silver.
- Phosphor bronze.

High resistance

- Silicon bronze.
- Phosphorized copper.

Very high resistance

- Cupro-nickel.
- Tough-pitch copper.

specific for any alloy system. Copper alloys are sensitive to an atmosphere containing ammonia, moisture and air. Ammonia is not a particularly common gas and it may logically follow that there are few locations where stress-corrosion cracking of copper alloys will occur. This reasoning is false because it assumes that only an appreciable amount of ammonia produces cracking. A trace amount is all that's needed and this may be present nearly anywhere. A source of ammonia in some locations is the breakdown of protein molecules.

Moisture is the second necessary ingredient of an atmosphere that will cause copper alloys to crack. Stress-corrosion cracking, like most forms of corrosion, is electrochemical and it involves metals in contact with an electrolyte such as an aqueous solution.

Finally, cracking requires air. Oxygen is a prerequisite of most corrosion, but in the stress-corrosion cracking of copper alloys, carbon dioxide also appears to play a vital role, so air rather than oxygen is necessary.

Gaseous ingredients produce rapid cracking. The worst condition involves metal wet with a thin film of moisture and surrounded by an atmosphere containing ammonia and air. This is not to say that stress-corrosion cracking will not occur if the metal is immersed in a solution of the necessary ingredients, but cracking will occur less rapidly.

The third major factor involved in stress-corrosion cracking is time. Perhaps this hardly needs to be mentioned, because all forms of corrosion require time. Time for cracking ranges from 5 min. under highly accelerated laboratory conditions to months or even years for resistant materials exposed to a mildly corrosive atmosphere. Degree or depth of cracking is not a straight-line function of time. There seems to be a long incubation period, following which, cracking occurs very rapidly.

▶ **Remove Stress**—Prevention of stress-corrosion cracking obviously depends on removing, eliminating, or canceling one or more of the responsible factors. By far the most effective calls for removing the stress that exists. Residual stresses can be removed by annealing. Relief annealing is annealing at a temperature where stresses are relieved but the metal is not softened. This requires accurate temperature control. Since only tensile stresses cause stress-corrosion cracking, it is possible to cancel the effect of such stresses by producing compressive stress in the surface layers of the metal. This should be done by vigorous scratch brushing, shot peening, or similar mechanical treatments.

▶ **Keep Corrodent Away**—Excluding the corrodent from the metal surface is somewhat less effective than removing the stress, in preventing stress-corrosion cracking. Protective coatings such as metal plating or organic finishes frequently have negligible effects on cracking. If the atmosphere contains large amounts of ammonia, something can be done to eliminate it, but the commoner trace amounts defy detection or removal.

It would rarely be feasible to remove air from the environment, but sometimes moisture can be kept from the metal surface. Not infrequently stress-corrosion cracking occurs because the metal has passed from a cool to a warm, moist atmosphere. A film of moisture condenses on the metal and conditions are ripe for the solution of a trace of ammonia in the water and rapid formation of cracks in the metal.

▶ **Better Alloy**—Brass is extremely susceptible to stress-corrosion cracking. Other copper alloys are less susceptible and pure copper is immune. It follows that a third way to reduce the probability of cracking is to select a resistant alloy. Knowing the relative resistance of the several copper alloys helps in predicting their behavior under conditions where they might fail by stress-corrosion cracking (see table, left).

Besides the three major factors there are minor ones that affect the rate at which a metal will stress-corrosion crack. One of these is strength. Other things being equal (if such a condition could be imagined) a strong alloy has better resistance to stress-corrosion cracking than a weak one. If this statement is extrapolated it follows that cold-rolled metal has better resistance to stress-corrosion cracking than annealed metal. This has been found to be true provided the metal is under an applied stress and not a residual stress from cold working. These factors are shown on p. 130.

▶ **How to Detect**—It is convenient to have a simple laboratory test that will differentiate between the resistance of copper alloys to stress-corrosion cracking. The mercurous nitrate test (ASTM B-154) is not such a test. It only reveals the presence of residual stress that might cause stress-corrosion cracking. Since ammonia is the agent generally responsible for cracking in service, it follows that ammonia is the logical medium in which to make tests.

When comparing different alloys, the specimens may be bent into a U or a closed loop and exposed to the ammoniacal atmosphere. Yellow brass will likely crack in half an hour but metal that does not crack in a couple of weeks probably never will. To examine assemblies or parts to discover their need for

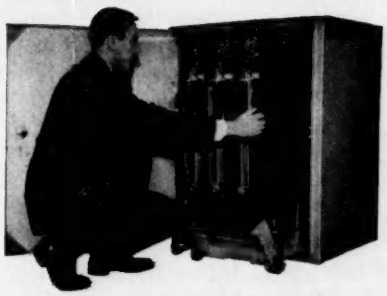
ALLIS-CHALMERS

New *SpaceMaker* control is the first completely new high-voltage motor controller in more than a decade. It is the first two-high, 2 to 5 kv control center, and the first in its voltage class with complete drawout construction for unprecedented safety and accessibility.

Inspection and maintenance are greatly simplified. One man can easily roll the carriage from the control enclosure for complete accessibility. Arc chutes and barriers lift out and the pole pieces rotate to expose the contact structure.

And, SpaceMaker control is completely safe. It is impossible to come in contact with "live" parts because the contactor is connected and disconnected with the door closed and live line connections are isolated by automatic shutters.

For complete details of the new, years-ahead SpaceMaker *controller, call your nearby A-C representative. Or write* **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1406



SpaceMaker is an Allis-Chalmers trademark.

relief annealing, a similar test, or the mercurous nitrate test, can be used. Specimens are degreased, rinsed, and while still wet with water, are hung in a covered vessel containing a quantity of ammonium hydroxide in the bottom.

▶**Avoidable Failures**—Typical example of a stress-corrosion cracking failure is a sprayer that was used for one summer for dispersing 2-4-D. It was stored for the winter and the following spring it was cracked beyond salvage. The shell was light-annealed 70-30 brass and the pump barrel was cold-drawn 85-15 red brass. Relief annealing the shell and the barrel, after forming, would have obviated the failure.

Another example is a coil of aluminum-bronze welding wire that cracked in storage. Wire was in the cold-drawn condition to give it sufficient stiffness so it could be pushed through the welding gun. Residual stress left by cold drawing was probably augmented by stress involved in winding.

Stress-corrosion cracking during storage appears to be the result of a sequence of atmosphere changes that leave a film of moisture on the metal. Even though the alloy is resistant and the ammonia is present only in trace amounts, stress-corrosion cracking will occur. The cure: relief anneal the metal or use heated storage to avoid a thermal excursion that might leave a film of condensed moisture on the metal.

▶**Exchanger Tubing** — Condenser and heat-exchanger tubes are frequently subject to some, but usually not all, of the factors that contribute to stress-corrosion cracking. Tubes may be admiralty or aluminum brass—alloys highly susceptible to stress-corrosion cracking. In surface condensers, condensing steam continually wets the tubes. Ammonia and amines may be added to boiler feed to raise the pH and reduce corrosion of ferrous parts of the power plant. However, a number of features keep such tubes from cracking. Air tends to be sparse in the condensing space. But, most important, tubes are supplied in the annealed condition and with careful handling they are free of stress when construction of the condenser is complete.

Admiralty tubes did fail in a feed-water heater in an atomic power plant, however. The tube was supplied in the annealed condition but was formed into a U-bend and not subsequently relief annealed. The fact that this was an atomic power plant had nothing to do with the cause of failure.

The photo on p. 128 is a photomicrograph at 75X of a stress-corrosion crack in a piece of leaded tube brass. This is a cross section and the crack is intergranular. Lead particles are visible in the structure. Stress-corrosion cracks in copper alloys are usually intergranular, but this is by no means always so and cannot be used to differentiate this type of cracking from other types. Admiralty and aluminum brass almost invariably crack transgranularly and brass frequently does so.

▶**Short End of Risk**—In summary it can be stated that the methods of avoiding stress-corrosion cracking of copper alloys are well known. In nearly all cases there is a practical method available, at a price. Armed with this knowledge, why should service failures by stress-corrosion cracking ever occur? Doubtless they are sometimes the result of ignorance.

More often stress-corrosion cracking occurs when the manufacturer (or perhaps his customer) comes out at the short end of a calculated risk. If the probability of stress-corrosion cracking is small, the cost of preventing it high, and penalties involved if it occurs are light, then the manufacturer will take the risk. It is when he miscalculates the risk that economic loss may result.

Meet the Author

DAVID H. THOMPSON *is a member of Anaconda American Brass Co.'s metallurgical dept. in Waterbury, Conn. Since his graduation from Yale in 1933, he has specialized in the area of stress-corrosion cracking of copper alloys and has authored several papers dealing with that subject and atmospheric corrosion. He is a member of AIME, NACE and the Electrochemical Society.*

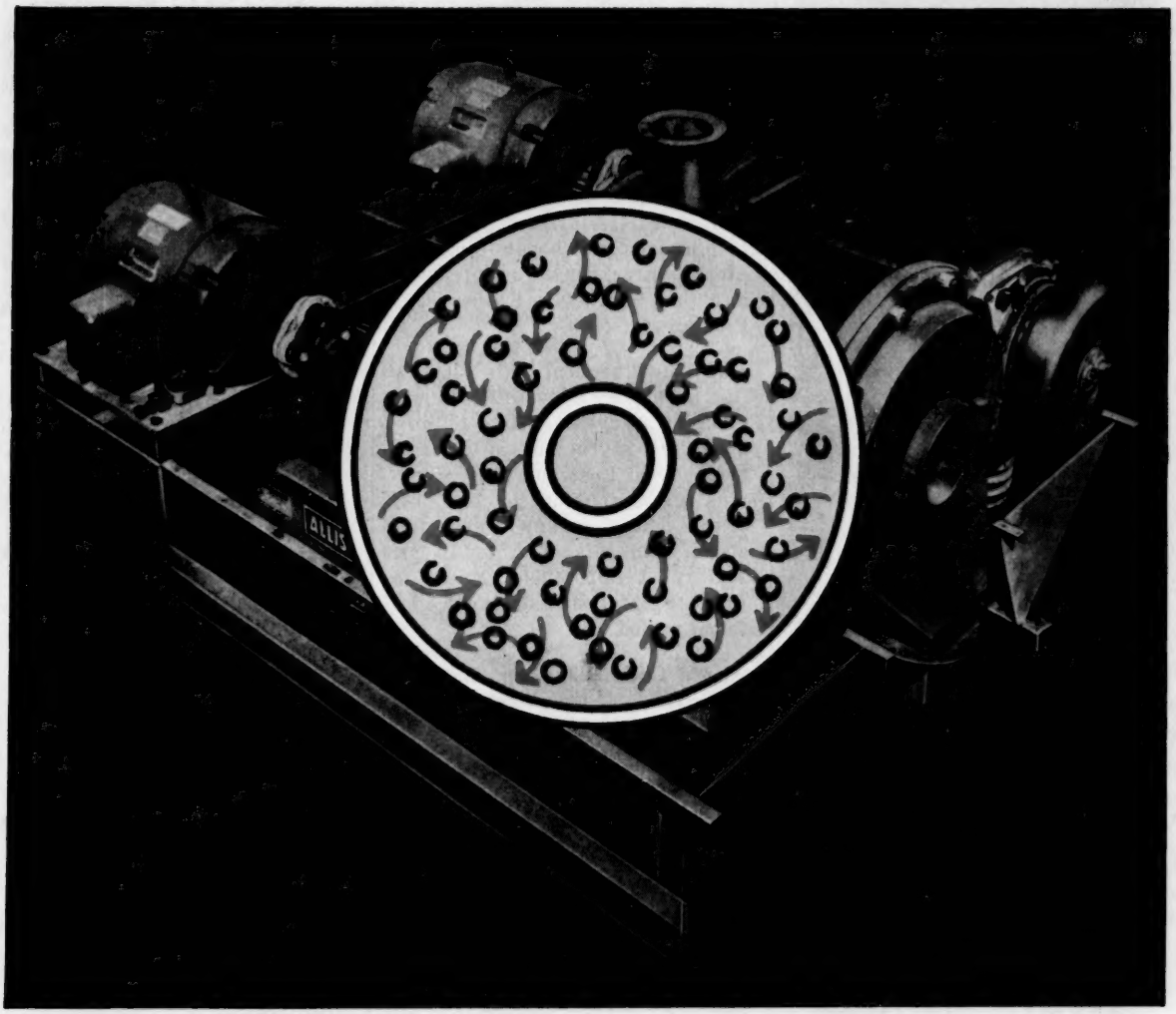
Big Things Brewing For Platinum

The trend toward higher processing temperatures and higher product purities is pushing sales of platinum and its sister metals ever upward, as corrosion becomes more of a problem. Latest sales figures of platinum group metals (platinum, palladium, iridium, rhodium, ruthenium and osmium) to consuming industries: 577,200 troy oz. for first nine months of 1960, compared with 558,500 oz. for the same period in 1959.

One reason behind the increase in consumption: more platinum is being used as a construction material. A number of synthetic- and glass-fiber plants use platinum orifices in extrusion equipment. Anodic-protection equipment, recently announcer by Continental Oil (*Chem. Eng., Sept.* 19, 1960, p. 218) will use platinum electrodes. The new electrodes developed for chlorine-caustic soda production are titanium coated with platinum.

According to Charles W. Engelhard, president of Engelhard Industries, "The platinum industry is on the threshold of a number of exciting new discoveries—discoveries which will pay off in benefits to consuming industries."

ALLIS-CHALMERS



Vibro-Action keys performance

makes this 30″ vibrating mill up to 30 times more productive!

You get maximum efficiency with this remarkable grinding action. With grinding media occupying approximately 80% of mill volume, the grinding charge vibrates at high speed. Grinding media works individually and as a mass between the center tube and shell liners.

Through this combination of high percent media loading, mass rotation and multiple impact, the charge swells to fill the entire mill with grinding fury. Top performance means this small vibrating mill outproduces a tumbling mill as much as 30 times per unit volume.

See your A-C representative for the details, or write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.*

Wide-range versatility. *Listed here are just a few of the many materials that are being processed efficiently with an A-C vibrating mill:*

Alumina • Aluminum-nickel alloy • Aluminum powder • Asbestos ore • Asbestos fibers • Barite • Blast furnace slag • Boron carbide Calcined magnesite • Coke • Copper ore • Dolomite • Feldspar Ferro-alloy, high-carbon, low-carbon • Glass shot • Hematite Ilmenite • Manganese ore • Kyanite • Limestone • Mica • Paint pulp Perlite ore • Phosphate ore and concentrates • Pigments • Quicklime Shale • Silica sand • Silicon carbide • Talc • Tungsten carbide Urea powder • Wood fibers • Zircon sand • Zirconium oxide.

A-1386

a

that

Designed for Chemical and Pharmaceutical Industries

Strahman

RAM TYPE

Drain Valves

The Strahman Drain Valve is the only valve that cannot clog up. It is so designed that in the closed position the piston or ram extends up into the tank thus preventing any possibility of the outlet becoming plugged.

In the open position, full and unobstructed flow is assured as the piston is drawn down into the bonnet leaving a completely open passage for the material passing through.

Write direct for complete catalogue

STRAHMAN VALVES, INC.

NICOLET AVE., FLORHAM PARK, N. J.

CPI NEWS BRIEFS . . .
(continued from page 60)

Hanna Furnace Corp., has announced a multimillion-dollar replacement and modernization program for its plant in Buffalo. Company will erect a battery of 50 coke ovens, replacing 20% of the plant's cokemaking capacity, and will install additional gas processing and pumping equipment. Construction is expected to start around March 1, to be completed about 10 months later. Contract for the oven replacement has been let to Koppers Co., Pittsburgh.

Monsanto Chemical Co.'s Plastics Div. is building a 50-million-lb./yr. plant at Addyston, Ohio, to produce new styrene-based plastics tradenamed Lustran. It is scheduled for completion the last half of this year. Company is operating a semicommercial, 6-million-lb./yr. facility at Springfield, Mass., to produce the plastics during the interim period.

Amoco Chemicals Corp., Chicago, will build a hydrocarbon-resins plant at Texas City, Tex., adjacent to American Oil Co.'s refinery there. Facility will occupy about eight acres, is scheduled to be completed this year. Output will be sold under the Panarez tradename, and the plant will double Amoco Chemicals' capacity for hydrocarbon resins.

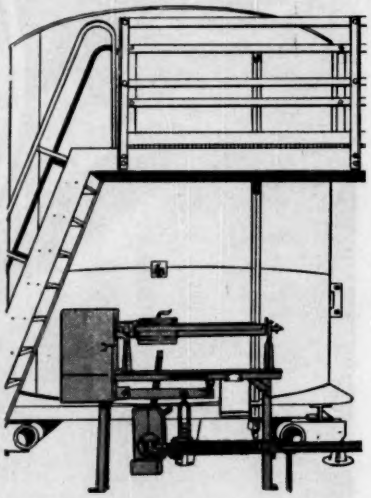
Dixie Chemical Co., Houston, is expanding its facilities for "custom chemical processing" in that city by erecting a fractionation unit. Dixie's facilities treat byproduct or waste streams from nearby operations of other firms, upgrading them and separating them into specification-grade products. The new fractionation unit features a column 80 ft. high and 4 ft. in diameter, which contains 40 sieve trays.

Aluminum Co. of America has started operations in a modern new die-casting plant at Edison, N. J. It contains 260,000 sq. ft. floor space, will employ 750 persons when producing at full capacity. At present the plant carries out only die-casting operations on

Cut Maintenance Costs in the CHEMICAL INDUSTRY

with MURPHY *Cardinal*

all-steel INDUSTRIAL SCALES!



The Original "ALL STEEL" Construction BUILT TO LAST A LIFETIME!

Can Be Custom-Built to Your Specifications

Murphy-Cardinal hopper or tank scales are designed specifically for the Chemical Industry. Shallow construction of Murphy-Cardinal scales makes them ideal for installations where minimum headroom is desired. Blueprints furnished to insure your scale will fit hopper or tank.

★ Most Deliveries in 10 days

★ NATIONWIDE SERVICE

Every type of Scale to meet every possible use in the Chemical Industry!

WRITE FOR INFORMATION AND PRICES TO

Cardinal

SCALE MFG. CO.

108 P.O. Box 151 Webb City, Mo. also Sacramento, California

THE ROTARY UNION*

PSC

The Rotating Seal That Solves Installation Problems

Unusual installation angles, worn machine connections, or the use of a wide variety of gases or fluids—none of these present problems to the Rotary Union. The unit automatically compensates for stress and strain and maintains a tight seal under the most adverse conditions, and each type will handle vacuum and most fluids and gases.

Rotary Unions are furnished with either right or left hand pipe threads in plain or syphon types. Special adaptors or fittings are supplied where needed and engineering service is available for O.E.M. applications.

There is a standard type and size Rotary Union for heating or cooling any revolving roll or drum. Pipe sizes ¼" through 5". Write for Bulletin 700 today.

*Trade Name—Patented

"WHERE *Good Connections* COUNT"
PERFECTING SERVICE COMPANY
332 Atando Ave., Charlotte, N.C.
Baltimore—Buffalo—Camden, N. J.—Chicago—Cleveland
Los Angeles—New York—Providence—Montreal—Toronto

aluminum, but it will also manufacture permanent aluminum mold castings after additional facilities are installed this spring. The Edison works will supplant Alcoa's die-casting works at Garwood, N. J., and the firm's permanent-mold foundry at Bridgeport, Conn., both of which will cease production next year.

Associated Chemicals Co. announces that it is now producing solid alum at its new plant in Pomona, Calif.

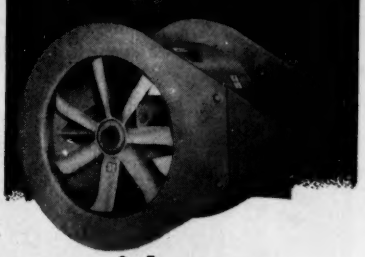
Darling Valve & Mfg. Co., Williamsport, Pa., has started operations at its bronze foundry in that city, following a modernization program that has almost doubled capacity. New melting capacity is 12,000 lb./day, and 1,600 lb. bronze can be melted and poured at one time. Plant can also handle other alloys, including ones containing aluminum.

Sunray Mid-Continent Oil Co.'s subsidiary, Suntide Refining Co., plans to start constructing a 30-million-lb./yr. ethyl benzene separation unit on March 1 at its refinery in Corpus Christi, Tex. Facility will operate in conjunction with the refinery's Udex (UOP aromatics-extraction) unit and orthoxylene-separation plant. Process design, engineering and construction will be by Badger Mfg. Co., Cambridge, Mass., and the new unit is scheduled for completion early in July.

Baird-Atomic, Inc., Cambridge, Mass., which specializes in scientific instrumentation, has acquired a manufacturing plant in Waltham, Mass., to house its activities connected with defense contracts. Facility contains 40,000 sq. ft., occupies a 5-acre site. Production of commercial instruments will continue at the firm's plant in Cambridge.

Milton Roy Co., St. Petersburg, Fla., will add 8,000 sq. ft. to its current 18,000-sq. ft. plant at Pinellas Park in suburban St. Petersburg. Company's Florida operations are concerned almost

combat CORROSION the modern way . . .



with new

Aerovent
FIBER GLASS
DUCT FANS

Featuring a unique built-in orifice and tear-drop shaped belt housing, Aerovent *Fiber Glass* Duct Fans are designed for your "*problem*" ventilating requirements. Virtually unaffected by normal concentrations of corrosion and most forms of chemical attack, *fiber glass* – used in the construction of the fan housing and other internal surfaces – assures longer, more dependable service in even the most difficult applications.

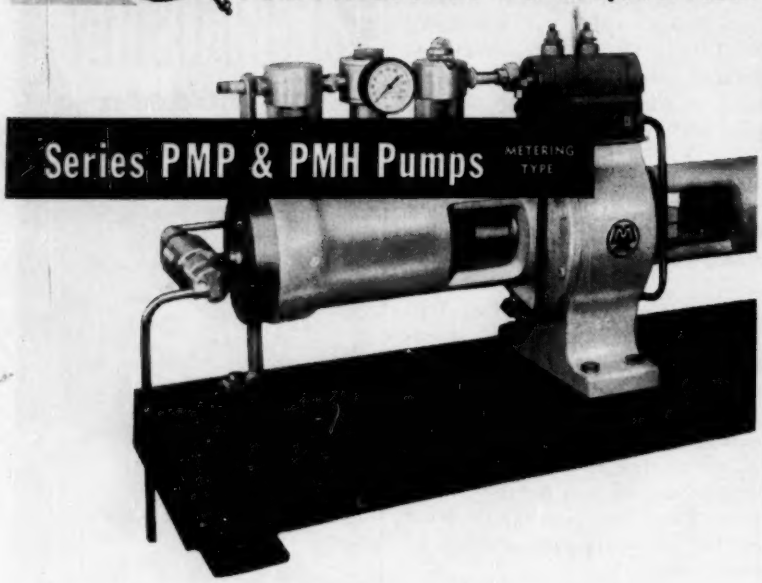
Propellers are stainless steel or Dura–a special alloy created by Aerovent for better resistance to corrosive atmospheres. Available in 17 models in sizes 14" to 42" for capacities to 32,500 cfm.

write for bulletin 175

CERTIFIED PERFORMANCE

Aerovent
FAN COMPANY, INC.
Ash and Bard Streets, Piqua, Ohio

Proportioning Pumps
FOR PRESSURES TO 100,000 P.S.I.



AIR, GAS OR HYDRAULICALLY DRIVEN

- Light Weight—High Tensile Cast Aluminum Frame
- Built-in—Heating or Cooling Jackets
- Interchangeable—Piston-Cylinder Assemblies
- Wide Pressure Range—To 100,000 P.S.I.
- Capacities—From 1½ gph to 200 gph
- Compact Design—Only 12"x42"x21"
- Carbide Pistons—For Heavy Service
- Through Type Bore—

For unusual application or for specific information concerning any high pressure equipment, contact our engineering department.

"SERVING THE FUTURE TODAY"

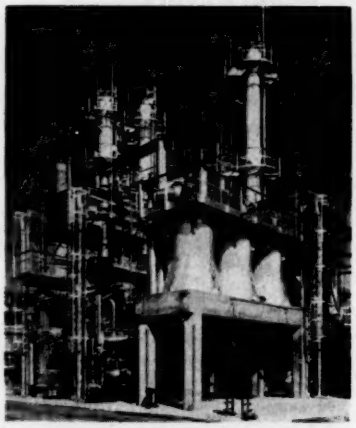
McCARTNEY
Manufacturing Company, Inc.
BAXTER SPRINGS, KANSAS

CPI NEWS BRIEF . . .

entirely with production of analytical chemical instruments, and the addition will house a Research & Development Div.

University of Wisconsin has placed a nuclear reactor into operation at its campus in Madison, Wis. Purchased under a $150,000 grant, the facility operates on 8 lb. uranium. It will be used for advanced research in nuclear engineering, and also for work in biology, chemistry, and medical and agricultural research.

Automatic Plastic Molding Co., Berkeley, Calif., is installing a new injection press as part of a continuing expansion and modernization program. Facility can turn out lightweight products, operates automatically with attention from only a standby operator. Mold clamping pressure is 100 tons.



Continental Oil Co., Houston, has placed a new, $1-million cyclohexane plant on stream at its refinery in Ponca City, Okla. Unit, shown above, has capacity of over 20 million gal./yr. It will convert benzene to cyclohexane by using hydrogen from the refinery's catalytic reformers. Construction was by Procon, Inc., Chicago.

Offices

Rogers, Inc.'s Brein-Knecht-Heimann Co. Div., San Francisco, will

build a $2.5-million office and warehouse at Brisbane, Calif. It will be a one-story building containing 235,000 sq. ft., located on a 15-acre site. Company plans to move from its present headquarters into the new facility in October.

Radio Corp. of America's Electronic Data Processing Div. has opened a sales office in Syracuse, N. Y., to service the upstate-New York area.

Western Petrochemical Corp.'s Warwick Wax Div. has established a West Coast sales district, with headquarters in Pomona, Calif.

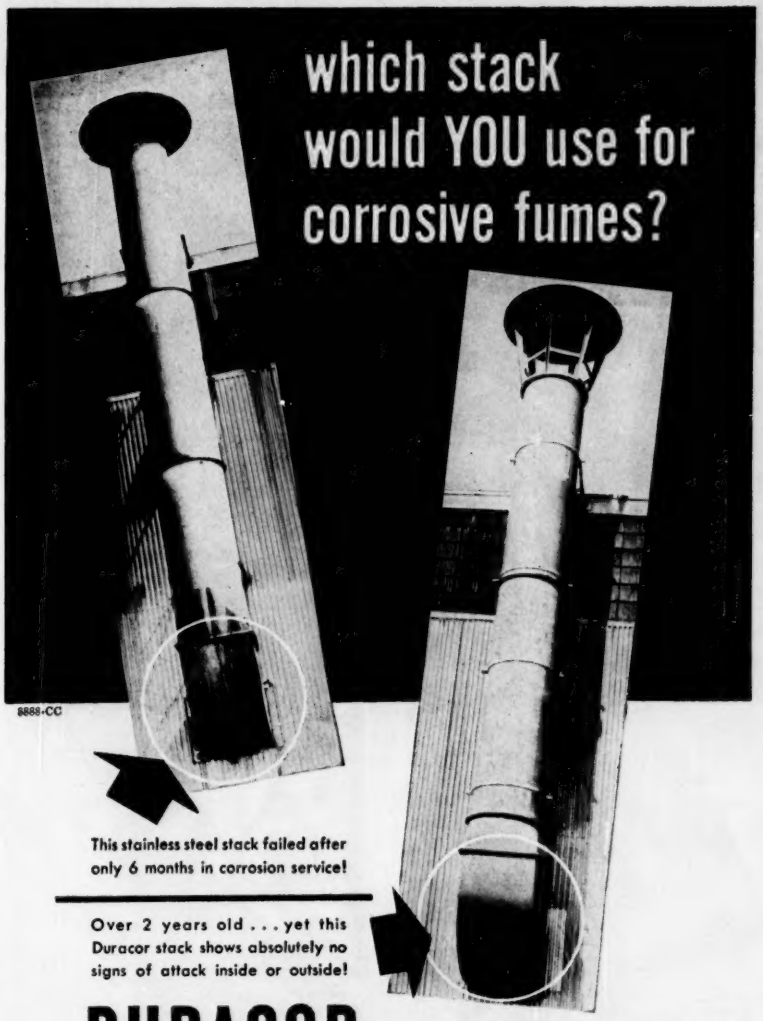
Hagan Chemicals & Controls, Inc.'s Oilfield Div. has opened a new sales and service office in Casper, Wyo.

Companies

Arkansas Chemicals, Inc., is a new corporation formed jointly by Houston Chemical Corp. and Great Lakes Chemical Corp. It is building a bromine plant in Arkansas, will sell part of its production to each of the parent firms. The plant is due to be completed early this year.

Houston Chemical will use its portion of the output to make ethylene dibromide, a component of TEL and TML gasoline additives. (This firm is currently constructing a multimillion-dollar TEL-TML plant at Beaumont, Tex., scheduled to go on stream Sept. 1.) Great Lakes Chemical will resell part of the bromine it receives, will use the rest to make ethylene dibromide, methyl bromide and other bromine compounds.

Metal & Thermit Corp., New York, is increasing its participation in the European market by forming a wholly owned subidiary, Metal & Thermit AG, in Zug, Switzerland. It will act as the parent company's sales and licensing representative in Europe, will also license its own patents and trademarks.


which stack would YOU use for corrosive fumes?
8888-CC
This stainless steel stack failed after only 6 months in corrosion service!
Over 2 years old . . . yet this Duracor stack shows absolutely no signs of attack inside or outside!

DURACOR VENTILATING SYSTEMS PROVIDE LASTING CORROSION RESISTANCE AT LOW COST!

Performance-proven Duracor Ventilating Systems and components provide outstanding resistance to attack from all types of corrosive fumes. These high-strength systems are corrosion-proof throughout . . . are practically immune to weathering . . . require only minimum support! Best of all, Duracor construction can save you up to 30% on your initial investment . . . and it's maintenance-free! Ceilcote engineers will design a complete Duracor system to meet your special requirements . . . or modify your present system to permit gradual conversion to Duracor. Fabricated to meet customer specifications . . . or assembled from stocked component parts . . . Duracor Ventilating Systems can be easily installed by regular plant maintenance crews or by experienced Ceilcote installation personnel. Write today for the new Ceilcote catalog.

DURACOR CEILCOTE

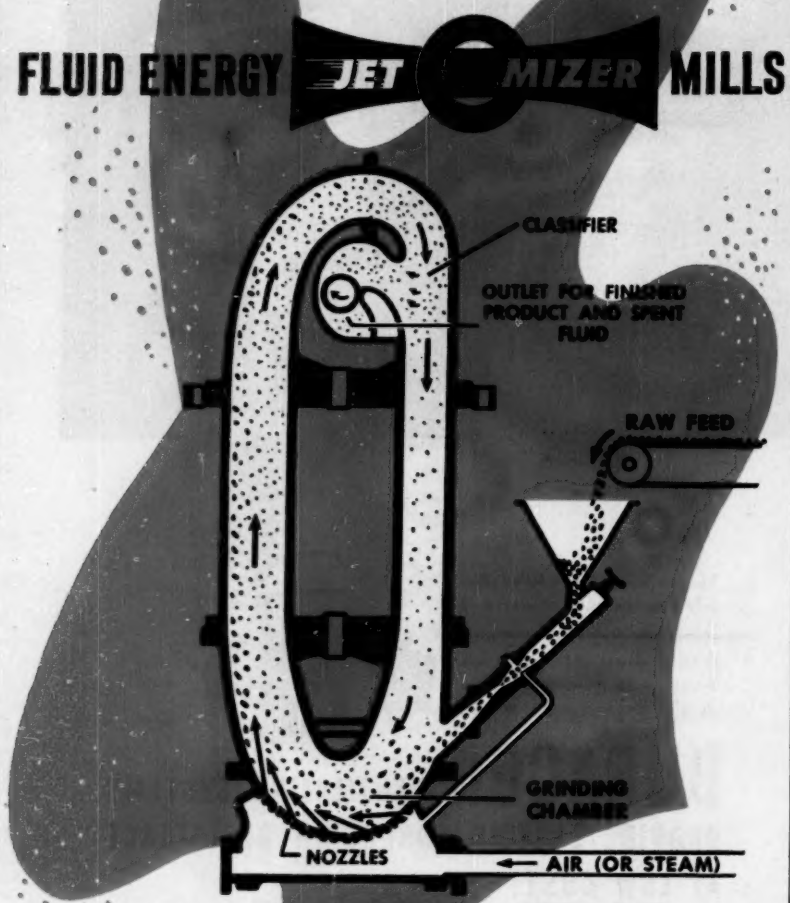
ANOTHER PRODUCT OF

THE CEILCOTE COMPANY, INCORPORATED

4836 Ridge Road • Cleveland 9, Ohio

for GRINDING AND DEHYDRATION
FINER PARTICLES
LOW MAINTENANCE

FLUID ENERGY JET-O-MIZER MILLS



The Fluid Energy "Jet-O-Mizer" Mill, designed and built by the pioneers in fluid energy fine grinding, does far more than produce fine particles. It controls fineness and product quality with a narrow distribution range and simultaneously with grinding can dehydrate, coat particles, blend and achieve chemical changes.

Jet-O-Mizer Mills are being used all over the world, processing many types of materials in the following industries:

• Abrasive	• Food	• Pigment	• Wax
• Insecticide	• Mineral	• Plastic	• Metal
• Ceramic	• Pharmaceutical	• Carbon	• Chemical

"Jet-O-Mizing" produces FINE PARTICLES ¼ micron average and above PLUS . . . Narrow Particle Distribution • Dry, or Controlled Moisture Content • Continuous Operation • Uniformity of End Product • Other Operations with Grinding • No Attritional Heat — No Moving Parts • Low Operating Costs • Low Maintenance

Send for complete information on Fluid Energy's "Jet-O-Mizer" Mills, "Jet-O-Clone" Dust Collectors, and TESTING AND CUSTOM GRINDING services.

FLUID ENERGY PROCESSING & EQUIPMENT COMPANY
Richmond & Norris Streets, Philadelphia 25, Pa. • Phone: Regent 9-7728
(Formerly known as the Wheeler-Stephanoff Mill)

Chemetron Corp., Chicago, has acquired Northwest Chemical Co., Detroit, a manufacturer of chemicals for the metalworking industry.

Cerro Corp. is the new name of the New York-based nonferrous metals firm formerly known as Cerro de Pasco Corp. The company's main mining and refining subsidiary, which operates primarily in Peru, will continue with its current name of Cerro de Pasco Corp., Incorporated in Delaware.

International

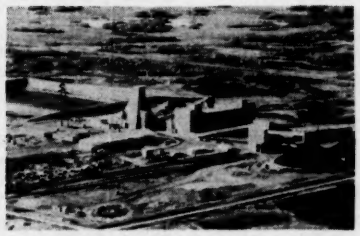
Australia: The United Kingdom's Laporte Industries Ltd. has completed an agreement with the Western Australian government to establish a $9.8-million titanium oxide plant at Bunbury. Capacity will be 10,000 long tons/yr. and the facility is scheduled to start production by '64.

Holland: Netherlands State Mines will build Holland's first formaldehyde plant, at the firm's plantsite in Beek. Product will be finished as a 40% solution in water, and plant capacity will be 25,000 tons/yr.

England: The Heavy Organic Chemicals Div. of Imperial Chemical Industries, Ltd., will substantially boost its capacity to produce alcohols by carbonylation of olefins, by erecting a 30,000-ton/yr. plant at Billingham, in northern England. This project plus planned expansions of existing alcohol units will raise ICI's total alcohols capacity to over 140,000 tons/yr.

France: Societe Europeene du Bore (SEUROBOR) is a new company formed jointly by American Potash & Chemical Corp. and France's Societe D'Electro-Chimie D'Electro Metallurgie et des Acieries Electriques D'Ugine; it will build a $2-million plant to produce boric acid at Pierre Benite, near Lyons. Ugine currently pro-

duces perborates and other boron derivatives at that location, and will manage the manufacturing activities of the new operation. Product will be marketed throughout Europe by Borax & Chemicals, Ltd., American Potash's European selling organization.



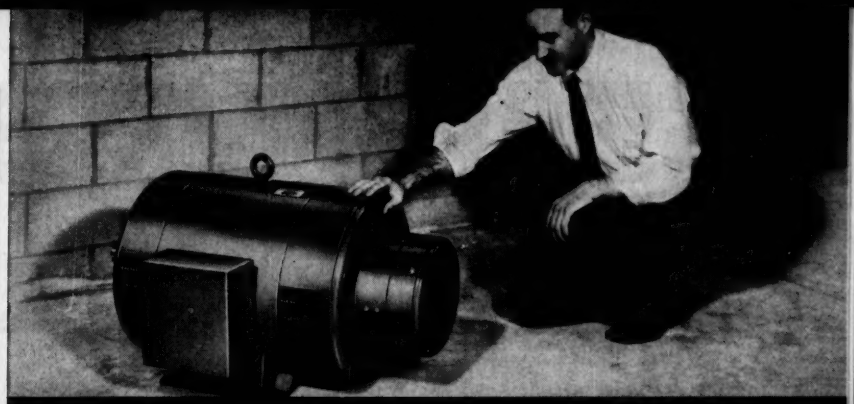
Canada: International Minerals & Chemical Corp. (Canada), Ltd., reports continued progress in shaft sinking at its forthcoming potash mine near Esterhazy, Sask. Shown above is part of the adjacent refinery at which International will process the potash.

The potash deposit, described by International as the world's largest high-grade one, is at a depth of about 3,150 ft. Company hopes to have the mine in operation by fiscal 1961-1962.

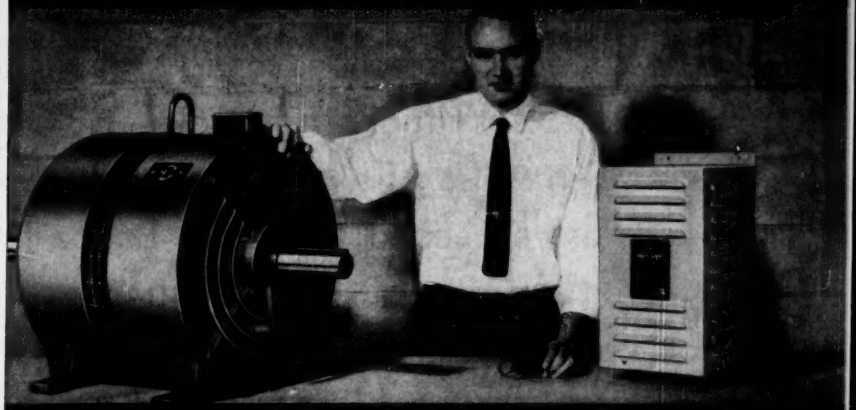
Holland: Chemische Industrie Uithoorn N.V. is erecting a 5,000-ton/yr. phthalic anhydride plant at Uithoorn, hopes to have it completed by spring of '62. Cost will be about $1.9 million. The facility will be designed to operate with either naphthalene or orthoxylene as feedstock.

West Germany: Knapsack-Griesheim AG., a Hoechst subsidiary, plans to build a $5-million chlorine-alkali electrolysis plant at Knapsack, near Cologne. It is scheduled to start operating this summer.

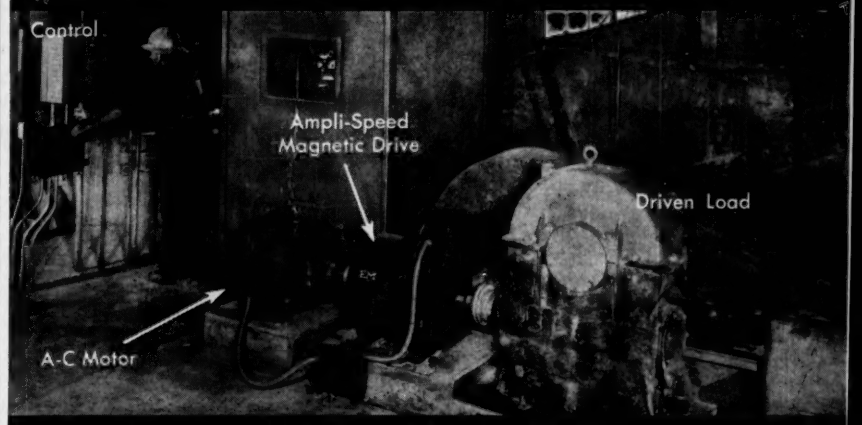
Brazil: Cyanamid International, a division of American Cyanamid Co., New York, announces that it has bought facilities of Plasticos do Brazil, S.A., which will be used to manufacture laminated plastics. The facilities are at Sao Paulo, and will be operated by a newly formed Cyanamid subsidiary, Formica Plasticos, S.A.



YOUR CONSTANT SPEED MOTOR



PLUS E-M AMPLI-SPEED DRIVE



GIVES ADJUSTABLE SPEED CONTROL

. . . it's that easy to have precise, adjustable speed control on fans, compressors, centrifugal pumps, conveyors, a-c frequency stabilizers, machine tools, etc.

Ampli-Speed is a simple, compact magnetic slip coupling that is:

EASILY ADAPTED – it may be either belted or coupled to your motor and load.

SIMPLE TO INSTALL – it's air cooled and can be handled and installed just like a motor.

EASY TO CONTROL – speed is changed by simply turning control potentiometer . . . output may be controlled automatically, too, by pressure, level, or combustion devices.

Ampli-Speed has nearly stepless speed change and gives speed regulation within ± 2%. It's available in these integral horsepower ratings: thru 310 hp for variable torque loads; thru 75 hp for constant torque loads. Input speeds can be 860 thru 1750 rpm.

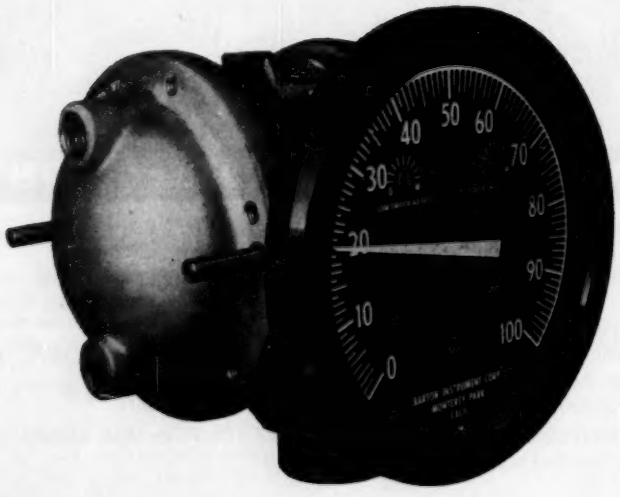
WRITE FOR FREE LITERATURE – Illustrated publication No. 243 tells how Ampli-Speed works and how to select right model from easy-to-use charts. Write the factory for your free copy and see your nearby E-M Sales Engineer for expert help with speed control.

Somewhere in your plant an operation can be improved with adjustable speed control . . . DO IT YOURSELF WITH AMPLI-SPEED

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

SENSITIVE SENTINEL

is a good description of the Barton 257 differential pressure indicating switch. Accurate, responsive, easy to read and infinitely dependable, the 257 is ideal for energizing alarm circuits when limits of flow, level, or differential pressure are exceeded. Like many Barton instruments, the 257 D.P. switch has as its heart the rupture-proof dual bellows Barton meter body—proved beyond doubt to be the finest in the field. For new standards of accuracy and dependability in your measurement and control instruments, look to the leader—buy **BARTON**®



BARTON INSTRUMENT CORPORATION • MONTEREY PARK, CALIFORNIA

Convention Calendar

February

5-10. National Petroleum Assn., Symposium on Research on Gasoline, Benjamin Franklin Hotel, Philadelphia, Pa.

7-9. The Society of the Plastics Industry, Inc., 16th Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

9-11. National Society of Professional Engineers, Winter Meeting, Hotel Fort Des Moines, Des Moines, Iowa.

13-16. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 15th International Heating & Air-Conditioning Exposition, Chicago Amphitheatre, Chicago, Ill.

13-17. American Management Assn., Inc., Packaging Management Course, Hotel Astor, New York, N. Y.

16-17. American Society for Metals (Albuquerque and Los Alamos Chapters), Symposium on Recent Developments in Materials for Nuclear Applications, University of New Mexico, Albuquerque, N. M.

20-23. National Council for Stream Improvement, Inc., Annual Meeting, The Waldorf-Astoria Hotel, New York, N. Y.

20-23. Technical Assn. of the Pulp and Paper Industry, 46th Annual Meeting, Hotel Commodore, New York, N. Y.

26-2. Society of Petroleum Engineers of the American Institute of Mechanical Engineers, Annual Meeting, Chase & Park Plaza Hotels, St. Louis, Mo.

26-1. American Institute of Chemical Engineers, Petroleum and Petrochemical Exposition, National Meeting, Municipal Auditorium, New Orleans, La.

26-1. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 90th Annual Meeting, Chase Park Plaza & Ambassador Hotels, St. Louis, Mo.

March

5-9. The American Society of Mechanical Engineers and The U. S. Department of Defense, 6th Annual Gas Turbine Conference and Products Show, Shoreham Hotel and Pentagon, Washington, D. C.

7-9. The Material Handling Institute, The Industrial Truck Assoc., Spring Meeting, Sheraton Blackstone Hotel, Chicago, Ill.

13-17. National Assn. of Corrosion Engineers, Annual Conference & Corrosion Show, Statler Hotel, Buffalo, N. Y.

15-17. Natural Gasoline Assn. of America, 40th Annual Convention, Baker Hotel, Dallas, Tex.

20-24. American Society of Metals, 12th Western Metal Congress, Ambassadore Hotel, and Western Metal Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

20-31. Purdue University, 9th Annual Industrial Packaging Course, LaFayette, Ind.

21-23. Illinois Institute of Technology and American Society of Mechanical Engineers, American Power Conference, Sherman Hotel, Chicago, Ill.

27-29. Midwest Gas Assn., Annual Meeting & Convention, Sheraton-Fontenelle Hotel, Omaha, Neb.

27-31. American Institute of Physics, Instrument Society of America, and National Bureau of Standards, 1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, Columbus, Ohio

April

6-7. American Society of Mechanical Engineers, Management Engineering Conference, Statler-Hilton Hotel, New York, N. Y.

10-11. American Society of Mechanical Engineers, Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

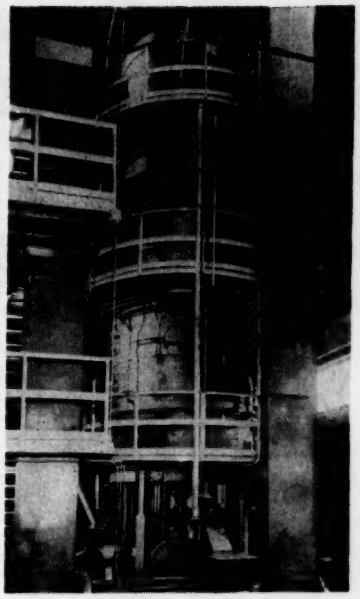
10-11. The Combustion Institute, Western States Section, 1961 Spring Meeting, Aeronutronic, Newport Beach, Calif.

10-12. American Welding Society, 42nd Annual Convention and Welding Exposition, Technical Meetings at Sheraton-Atlantic and Commodore Hotels, Show in New York Coliseum, New York, N. Y.

10-12. Western Petroleum Refiners Assn., 49th Annual Meeting, Grenada Hotel, San Antonio, Tex.

10-14. Greater New York Safety Council, 31st Annual Safety Convention & Exposition, Statler-Hilton Hotel, New York, N. Y.

11-13. Air Force Research & Development Command, Conference on Ultrapurification of Semiconductor Materials, New England Mutual Hall, Boston, Mass.



If you have a Drying, Roasting, Calcining or Decomposing problem...

a Skinner Furnace

may be the answer

Successful applications of the Skinner Furnace include:

Oxidizing Roast
- Roasting Molybdenum Sulphide Concentrates
- Roasting Zinc Ores
- Calcining of Basic Alum, Clays, Foundry Sand, Carbon, etc.
- Incineration of Sewage

Chloridizing Roast
- Roasting Uranium-Vanadium Ores

Reduction Roast
- Decomposition of Oil Sludge
- Lime Burning
- Manganese Reduction

Drying
- Drying Uranium-Oxide Precipitate
- Drying Copper Concentrates
- Dehydration of Alunite

Many other applications are possible ***because of the flexibility in construction and operation of the Skinner Furnace...***

- 2 to 14 hearths
- 4'0" to 23'6" dia.
- 22 to 4000 sq. ft. hearth area
- Direct or indirect fired with coal, oil or gas
- Variable rate of feed and retention time
- Up or down draft
- Handles any solids.. slimy, sticky, loose, coarse
- ¾" to minus 325 mesh material
- 200° F. to 2000° F... precise control of process temperature
- 100 to 50,000 lbs. per hour

We are equipped to work with you on your problem...
...over 40 years experience

The Company that cares enough to give you the best!

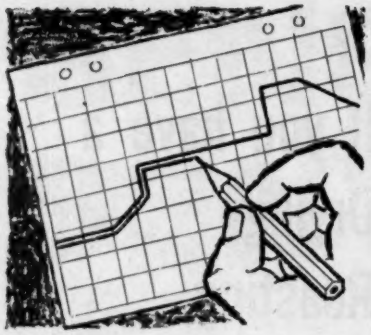
WRITE TO MANUFACTURING DIVISION

MINE AND SMELTER SUPPLY CO.

Denver 16, 3800 Race St. | New York 17, 122 E. 42nd St | Salt Lake City 1, 121 W. 2nd S. | El Paso, 1515 11th Ave. | Albuquerque, 701 Haines N.W

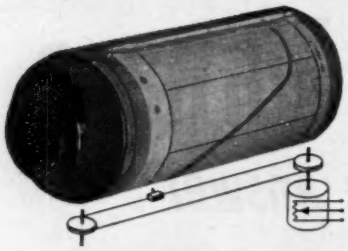
LICENSED MANUFACTURERS AND SALES AGENTS in Canada, Australia, Sweden, England, South Africa

Sales Agents in Peru, Chile, Philippine Islands, Japan, New York City (for Continental Europe) and in principal cities of the U. S



Plot your program with a pencil on ordinary graph paper

DATA-TRAK® will **follow** it



NEW

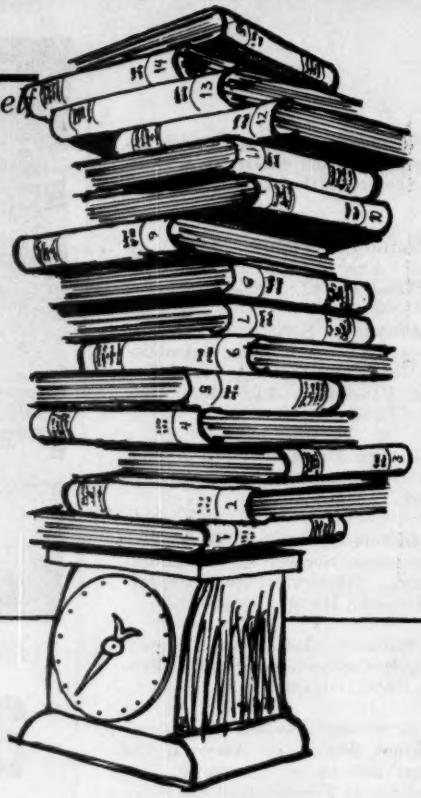
Now, with only an ordinary graphite pencil and graph paper, you can feed program instructions to automatic process controls. Data-Trak follows pencil-drawn graphs anyone can prepare. High degrees of accuracy and reliability result from use of unique capacitive curve-following principle. Potentiometer output is proportional to drawn curve.

Graphs last indefinitely because stylus doesn't touch the paper. Data-Trak drum speed is variable, can even be programmed automatically. Drum rotates continuously on some models for cyclic programming.

RI RESEARCH INCORPORATED

Write Dept. CH, Box 6164, Minneapolis 24, Minn.

Technical Bookshelf



46 lb. of scientific knowledge from...

Abaca to Zythiaceae

THE McGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY. 15 vols. ED. BY W. H. CROUSE, ET AL. McGRAW-HILL BOOK CO., NEW YORK. 9,712 PAGES. $175 UNTIL MARCH 1; $195 THEREAFTER. UPDATING SUPPLEMENTS WILL BE PUBLISHED PERIODICALLY.

Ten tons of statistics have issued on this new work. The 15 volumes contain 7,224 articles in alphabetical order, size of articles ranging from 100 to 24,000 words. 2,015 contributors, elucidating to the over-all tune of about 6,283,000 words, have required 9,712 pages of text, filled an index with 100,000 listings. A cross-reference count shows 40,000 entries; there are 14,000 bibliographic citations; 9,800 illustrations abound, including 36 color plates. One last-gasp figure: first printing (of 25,000 copies) consumed 29 freight-car loads of paper.

In explaining content makeup and the general aim of the encyclopedia, Curtis Benjamin (then President, now Chairman, of the McGraw-Hill Book Co.) comments in the work's preface as follows:

"At the start . . . it was firmly decided that this must be a work *of*, not *about*, science and technology . . .

"The limitations of space were a major problem. Wide scope and the many borderline applications of science and technology made the problem especially difficult.

"The basic subject matter of all the natural sciences and all their major applications in engineering, agriculture, forestry, industrial biology, food and other technologies had to be included. But what about the behavioral sciences and the vast field of applied science represented by medicine, pharmacy and pharmacology? The problem was met by including only the preprofessional science of these related fields. Thus, physiological and experimental psychology are covered but not psychiatry or psychotherapy. And

biochemistry, embryology and anatomy are represented by basic articles but clinical medicine is not."

Another difficult decision: "To set limits on depth and detail . . . It was decided that inherent substantive complexity and sophistication would have to be the guide in each case. But it was also decided that each article would be so designed and written as to be understandable to the nonspecialist in its field.

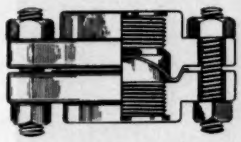
"And this principle stamps the basic purpose of the work: *To provide the widest possible range of articles that will be understandable and useful to any person of modest technical training who wants to obtain information outside his particular field of specialization.*"

This is the case as stated for the encyclopedia.

How well has the project been carried out? This reviewer would like to make two points: (1) work's greatest "extra" is the extremely comprehensive cross referencing contained not only at the end of articles but even within them; (2) in criticism—level of shorter contributions could have been more uniformly excellent. Criticism to the contrary, however, it would seem that the majority of superlatives fit, that even the most finicky pedant would acknowledge the work to be the scientific publishing coup of the decade.

However, let us move a step further. As a feature preview, and to let our readers in on subject content generally pertaining to interests of chemical engineers, *CE*'s editors have assumed roles as reviewers, have tackled those entries they feel particularly qualified to comment upon. Here, then, in sequence (and written completely independent of the above introduction) are their appraisals.—HSG

Cement/Concrete: A short section on portland cement (which comprises about 93% of all hydraulic cement used in the U. S.) describes the process briefly but effectively with the use of a simplified flowchart. No attempt is made to go into process variables other than listing the various raw materials



...Through this opening a tragedy safely passed

This "safety head" was ruptured in our lab. Enough high temperature steam passed through the opening to cause a process tragedy. Every day in the petroleum, petro-chem, chemical, power and aircraft industries safety heads are at work protecting pressure systems.

Used with or without a relief valve, the safety head is your way of being absolutely certain you have over-pressure protection. Let your BS&B man tell you about a safety head system for your process... or write to: Dept. 2-N2 7500 East 12th Street, Kansas City 26, Missouri, for further information.

BS&B BLACK, SIVALLS & BRYSON
KANSAS CITY • EDMONTON • LONDON • PARIS • THE HAGUE

ANACONDA CONDENSER AND HEAT EXCHANGER CLINIC

"Cupralum," lead-surfaced Anaconda copper tube, offers practical answers to some tough corrosion problems

If you'd be interested in more compact, more economical heat transfer units for handling corrosive liquors — sulfuric, chromic, phosphoric acids, sulfites, sulfates, alum, and the like — you should know about Cupralum*. Cupralum, a product of Knapp Mills, Inc., is Anaconda copper or copper-alloy tube to which a uniform, dense-structured, extruded chemical lead surfacing has been metallurgically bonded.

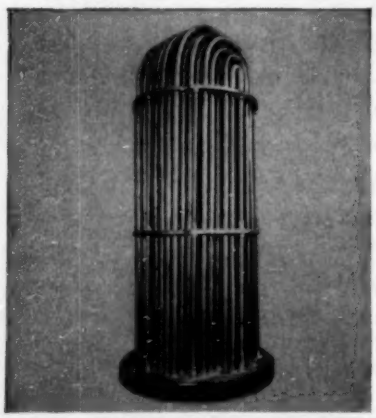
Alfred P. Knapp, chairman, Knapp Mills, Inc., explains to visitors how his company's patented drawing process metallurgically bonds lead surfacing to copper tube.

THE OUTSIDE lead surface, which may be from ⅛" to ½" thick, resists concentrations of acids—of sulfuric acid, for example, up to about 85% and up to 428 F. Being bonded to the copper, it expands and contracts with the copper during temperature cycling. Without the metallurgical bond, the lead would creep and eventually fail—an inherent weakness of all-lead tubing.

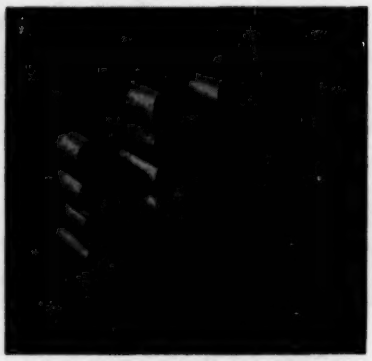
THE COPPER or copper-alloy tube inside provides strength to make Cupralum self-supporting — and to stand steam pressures up to 150 psi in standard wall thicknesses offered. It also provides its high corrosion resistance internally to cooling waters, steam, and refrigerants.

Most important, copper offers its high heat transfer rate. Because of the metallurgical bond with the lead, the over-all heat transfer rate of Cupralum is high—higher than all-lead tube and higher than that of iron and steel.

THE NET RESULT is that a given heat transfer job can be done with fewer square feet of surface — for a more compact unit. Or it is possible to get increased capacity in present existing space.



Two U-bend Cupralum tube bundles like this are used in a Ferrolum (lead-surfaced steel) separator tower to boil off ammonia from a urea carbonate ammonia solution—in the production of urea fertilizer. Anaconda copper tube core 1" O.D., 12 gauge, handles 150-lb. steam. Lead surface is 3/16 inch thick. Separator tower operates at 145 C (293 F) and 240 psi.



Lead surfacing removed from ends of Cupralum tubes preparatory to insertion in lead-clad steel tube sheet. Tube ends are usually rolled, but for severe thermal cycling service, may be brazed to outer steel face of tube sheet.

In many cases, the first cost of the coil is lower. Usually this is true where higher steam pressures than those previously used are available—or where expensive, hard-to-fabricate alloys have been used. Improvement of the heating or cooling cycle is another source of savings. Under any circumstances, a long operating life and easy maintenance provide over-all economy.

NUCLEONIC APPLICATIONS. Cupralum with a thicker surfacing of lead is being used increasingly in the nuclear industry. For gamma shields that must be cooled, Cupralum coils are built in to provide efficient heat transfer from the shield to the cooling medium.

Where radioactive liquors and spent resin discharge from demineralizers must be conveyed through process piping into process vessels for concentrating the radioactive solution, Cupralum piping prevents the escape of gamma radiation. In nuclear applications, the lead surfacing may be 1" to 8" thick.

Cutaway section of Cupralum tube. It is produced in 20' lengths or in long continuous coils —from 40' to 100' depending on diameter. It is easy to bend and fabricate. Reliable jointing techniques have been developed.

Lead surfaces of Cupralum tubes and of tube sheet are fused by lead-to-lead welding. Then an extra thickness of lead is applied at the joint for extra protection.

FOR MORE INFORMATION. For detailed data on Cupralum, write Knapp Mills, Inc., Wilmington, Del. Or see your Anaconda representative, who can also provide data on the full line of Anaconda copper and copper-alloy tubes—arrange for technical assistance in meeting special corrosion and heat transfer problems. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6071L

* Registered trademark of Knapp Mills, Inc.

ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Made by The American Brass Company

that may be used interchangeably.

All 11 pages devoted to concrete, concrete beams, columns and slabs are needed to describe the preparation and use of concrete. The authors have been generous with photos and drawings to display some of the more difficult concepts.

Perhaps more space could have been given to the uses for concrete, with illustrations of some of the modern applications in air terminals and other public buildings where shell roof construction can give vast areas of floor space free of supporting columns. Aside from that, the authors seem to have given a concise description of preparation and use of concrete—FCP

Centrifugation: Most certainly, if you are relatively uninformed about centrifugation, you will rapidly learn much about it from J. E. Flood's concise treatment of the field. But when you finish, you may still wonder:

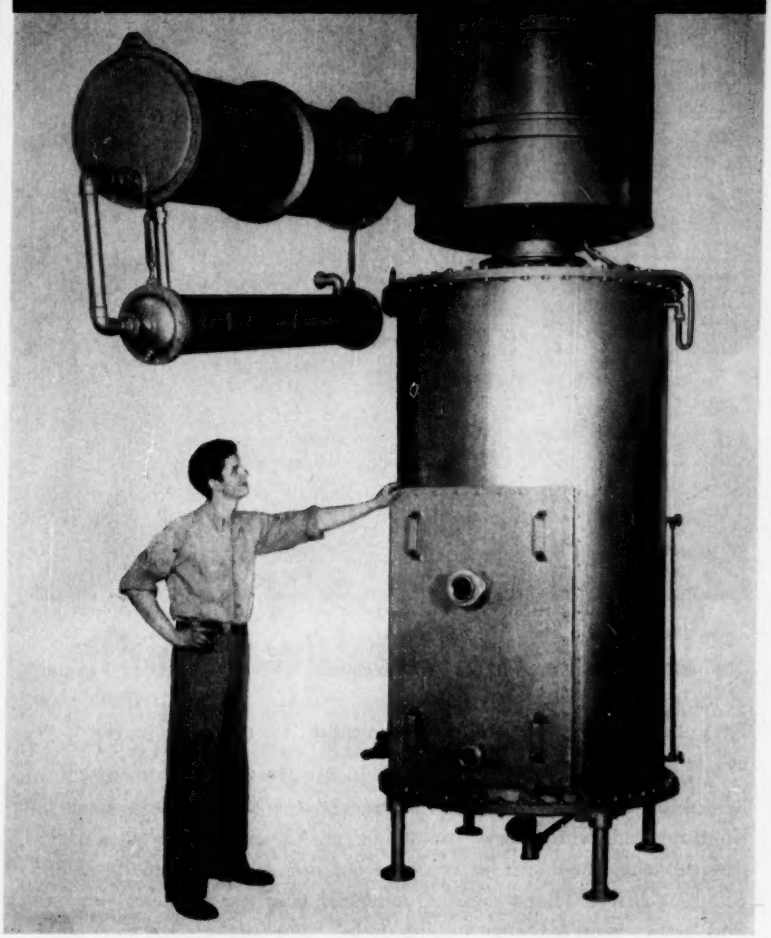
- Who uses centrifugation and for what purpose?
- What are approximate capacities and costs for typical industrial centrifugals?
- Where does this type of separation fit in the over-all family of mechanical separation operations?
- Why would anyone use one of these units rather than some other type of mechanical separator?

Answers to the third and fourth points may be deduced if you are sufficiently interested in the entire field of mechanical separations to look up the cross reference Separation, Mechanical, which is listed at the end of the centrifugation section. That will lead you, in turn, to a dozen or more cross references.

However, if you are primarily interested in only one type of mechanical separation, such as centrifugation, it would be helpful to learn at the beginning of the section that this is one segment of the mechanical separation field and its relationship to the whole.

In his coverage of centrifugation, Flood gives you a clearcut picture of how centrifugal force works to separate one substance from another. He establishes an average design surface-speed for centrifugal

BARNSTEAD ENGINEERED
DISTILLED WATER



FOR CHEMICAL, ELECTRONIC, NUCLEONIC, AND PROCESS INDUSTRIES

Barnstead Stills meet every laboratory and industrial requirement . . . from ½ gallon per hour for lab use to thousands of gallons per day for industral production. Today, more and more industries are turning to Barnstead . . . for the same reasons laboratories and hospitals adopted Barnsteads Stills years and years ago . . . highest purity distillate at lowest cost.

Barnstead Stills such as the SSQ-300 illustrated are standard in plants engaged in electronic, nuclear, atomic, pharmaceutical and allied fields where distilled water of highest purity is required.

Write for Barnstead Catalog "G" describing Barnstead Stills in capacities of from ½ to 1000 G.P.H.

Barnstead®
STILL AND STERILIZER CO.
4 Lanesville Terrace, Boston 31, Mass

SAN FRANCISCO
TEmplebar 2-5391
CHICAGO
ROgers Park 1-6173
CLEVELAND
ACademy 6-6622
BOSTON, JAmaica 2-8490
NEW YORK
Kingsbridge 8-1557
WASHINGTON, D.C.
District 7-1142
PHILADELPHIA
Wayne MU 8-2918
DETROIT
ENterprise 7422
LOS ANGELES
MUrray 1-6663
ST. LOUIS, MO.
WOodland 2-5600

NIAGARA VERTICAL FILTER AT KIND AND KNOX GELATIN COMPANY, CAMDEN, N. J.

"In half the time needed by our old filter press, we can run a batch of gelatin in the thin liquor stage through our new NIAGARA VERTICAL FILTER," says Edward Bohn Jr., assistant plant superintendent for one of the largest U. S. gelatin producers.

Remarkable reductions in down time and labor costs also are reported by Kind and Knox with its new NIAGARA FILTER. "Resetting the NIAGARA for a new run takes one-fourth the time and one man can handle the procedure without a helper," Bohn says. "Our regular filter press requires two men working two hours to change 50 filter cloths. With NIAGARA, hot water under pressure completely removes the residue in minutes, and the unit does not have to be opened. Also, there are no filter cloths to clean or replace in our NIAGARA FILTER."

The plant operates 24 hours a day, 7 days a week, and to date there has been no operational trouble with the NIAGARA FILTER. This compact filter has a base measurement of only 52" x 102", so there is a big savings in floor space.

For details on how custom engineered NIAGARA FILTERS can help with your processing problems, write for bulletin NC-457, or see the NIAGARA section in Chemical Engineering Catalog.

Niagara® FILTERS

A DIVISION OF

American Machine and Metals, Inc.

DEPT CEN—261

EAST MOLINE, ILLINOIS

Divisions of American Machine and Metals, Inc.

TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASER-STEERS CORPORATION

bowls, and shows how rotational speed and centrifugal force vary with bowl diameter as characterized by various types of centrifugal separators.

Sketches accompanying descriptions of these types do not indicate clearly which parts rotate. Good illustrations are imperative to an understanding of the operation of these machines. And, unfortunately, space limitations or editors' selection prevented illustration of all major types.—CSC

Chemical Engineering: One would think twice before criticizing a 1,000-word essay on Chemical Engineering signed with the initials S.D.K. To many members of the profession, Sid Kirkpatrick, our former Editorial Director, will always be "Mr. Chemical Engineering."

But the profession is in a state of flux, and S.D.K.'s Encyclopedia entry, prepared some two years ago, may soon need revision. Fittingly acknowledging the growing importance of the engineering sciences, the entry nonetheless leans heavily on the older unit-operation and unit-process concepts. We prefer Sid's most recent appraisal of the profession, the keynote address at our recent Conference on the New Chemical Engineering (see Dec. 12 issue).—CHC

Control Systems/Computers: This work contains many—by one count, 143—articles on control systems and computers. Coordinated by J. A. Hrones, Case Institute authority in these areas, the group includes Systems Engineering, Control Systems and Computer.

These three entries vary in readability and comprehensiveness. Systems Engineering, as seems to be true of many definitions of this area, leaves the reader with a "so-what" feeling by being too general.

Again, the 1½ columns on Computer leave the newcomer asking what a computer is and how it typically performs its functions. On the other hand, cross references to some specifics help one piece the story together. What's needed in the more-general article is the glue

to hold it in place. Talking to a chemical engineer in electrical engineering jargon doesn't help the former understand the latter; it may only confuse and repel him.

Ten pages on Control Systems, however, are well worth any chemical engineer's time. Well-illustrated by drawings and graphs, the section draws upon such phenomena as fluid flow and heat transfer to illustrate principles. Numerous cross references carry the reader to such specifics as pressure and temperature control.

The only general regret is that, though pithy and pertinent, many of the entries seem written for the expert rather than the well-trained layman. And why would experts turn to an encyclopedia for the information they need? Where does the layman go for his first information?—WCS

Corrosion: A review of this section can easily turn into a carping, hair-splitting, session. Almost anyone familiar with the subject can spot gaps in the treatment and suggest areas that should have been covered. But on the whole, the authors have written a good, simple introduction to the topic. The corrosion expert will find nothing new here; the intelligent layman will get a quick summary of the latest thinking.

However, all is not perfection. For some reason, the editors decided to have two authors: one to write on corrosion by liquids, the other on corrosion by gases. Unfortunately, there was little coordination by the parties concerned—the two subsections appeal to distinctly different audiences.

The liquid-corrosion author presents an excellent, practical discussion (of types of corrosive attack and how to reduce this attack) that appears to be directed to engineers. The gas-corrosion expert is much more interested in the theoretical aspects of his subject and on experimental techniques for investigating corrosion reactions by gases.

Good arguments can be made for either approach. But it is something of a jolt to finish reading about how proper equipment design can prevent liquid corrosion and then plunge into the details of a microbalance apparatus for meas-

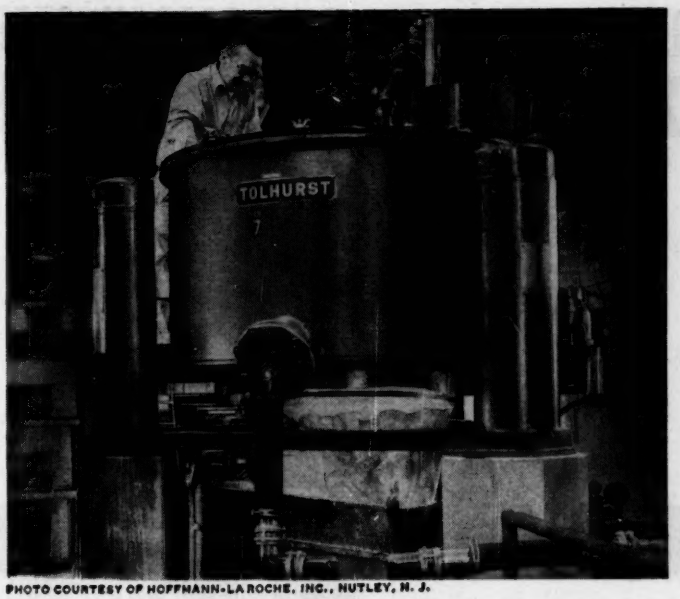


PHOTO COURTESY OF HOFFMANN-LA ROCHE, INC., NUTLEY, N. J.

Constant quality control and top efficiency with BATCH-O-MATIC®

This completely *automated* BATCH-O-MATIC reduces exposure time to maintain product stability in centrifugal extractor operations. These machines can be constructed of stainless steel, "Hastelloy," titanium or other alloys. Corrosion-resistant coatings may be specified.

Low, compact design and exclusive CENTER-SLUNG® suspension enable BATCH-O-MATIC to handle greater out-of-balance loads with minimum vibration. Low-speed plowing helps prevent crystal degradation. See complete data in the TOLHURST section of Chemical Engineering Catalog, or write today for further information or advice from experienced TOLHURST engineers.

MAIL COUPON TODAY

Tolhurst® CENTRIFUGALS

A DIVISION OF

American Machine and Metals, Inc.

Specialists in liquid-solids separation

Dept. CET-261, EAST MOLINE, ILLINOIS

Please send illustrated details on the BATCH-O-MATIC. I'd also like information on TOLHURST manual models ☐.

NAME

FIRM NAME

ADDRESS

CITY & ZONE STATE

Divisions of American Machine and Metals, Inc.

TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY GLASER-STEERS CORPORATION

FORGED STAINLESS AND CARBON STEEL
EXTRA-HEAVY UNIONS

FEATURE:

- DIMENSIONS TO AAR SPECIFICATIONS
- 45° CONE-TO-BALL SEAT INSURES TIGHT SEAL AND TURBULENCE-FREE FIT ACROSS SEATS
- HARDNESS DIFFERENTIAL BETWEEN SEATS TO AVOID GALLING
- TAPER REAMED TO INSURE FULL THREAD CONTACT OVER LENGTH OF THREAD

AVAILABLE IN:

STAINLESS STEEL (ASTM-A-182, Grades F-304, 316, 304L & 316L) in sizes ¼" thru 2" IPS, Screwed & Socketweld ends, 3,000# & 6,000# ratings.

FORGED STEEL (ASTM-A-105 Grade II) in sizes ¼" thru 3", 3,000# & 6,000# ratings. Screwed & Socketweld Ends. Nut cadmium plated to insure permanent lubrication.

THE Quality LINE IN FITTINGS
CAMCO
FITTINGS, INC.

SEND FOR COMPLETE CATALOG NO. 16-59

301 STATE STREET • NORTH HAVEN, CONN.

uring gas reactions on metals.—RBN

Cryogenics: The subject is covered under two headings in the encyclopedia—Cryogenic Engineering and Cryogenics.

The first of these is a good expository presentation that outlines the reasons behind the present great interest in cryogenics and describes its fields of application. Topics covered include: nuclear, military and space applications and the use of cryogenic fuels; chemical engineering applications such as the production of liquid oxygen and hydrogen; metal working applications with a discussion of the growing use of liquid oxygen in steel making; etc.

This section should give the technically oriented reader and, to a lesser degree, the layman, an appreciation of the growing importance of this new technology.

Contrary to expectation, the second entry, Cryogenics, repeats very little of the first. Here, the thermodynamics of low-temperature production and maintenance is discussed. The author confines himself to the theoretical with little attention to the machinery involved. To appreciate this section, the reader will require a basic understanding of thermodynamics—it is not for the layman.

The bibliographies for both these sections are rather sketchy but several interesting cross references are given, for example, Liquefaction of Gases, Helium, the Cryotron, Low-Temperature Physics.—JRM

Food Engineering: The 25 pages submitted by ten specialists on the subject provide a very comprehensive coverage of the many unit operations involved.

Section opens with a concise definition followed by a short rundown on educational requirements of the food engineer. A few outstanding achievements in the field are cited.

Next comes a brief but excellent discussion of the different unit operations, with more specific information on each of these being provided in subsections. Areas covered: general operations, raw-materials preparation, raw-ma-

terials conversion, food packaging, packaging materials, packaging methods. The text is further clarified by good photographs and line drawings of equipment units and processes.—AVG

Nuclear Technology: A studious reader of the sections that pertain to nuclear technology will not find himself immediately qualified as a nuclear scientist or reactor engineer. He will, however, gain a far broader knowledge of the field, in less time, than he is likely to get from reading highly technical treatises and magazine articles. And he will get a much deeper understanding of the subject than he can by reading popularized books and articles or even the more respected encyclopedias.

There does seem to be too much repetition of material, however. Much that is contained in the section on Nuclear Fuels is repeated at length in Reactors, Nuclear or vice versa, depending on which section you read first. The same goes for the sections on fuel processing and radioactive waste disposal. In some instances, though not in the nuclear sections, identical material by different authors is presented under different headings.

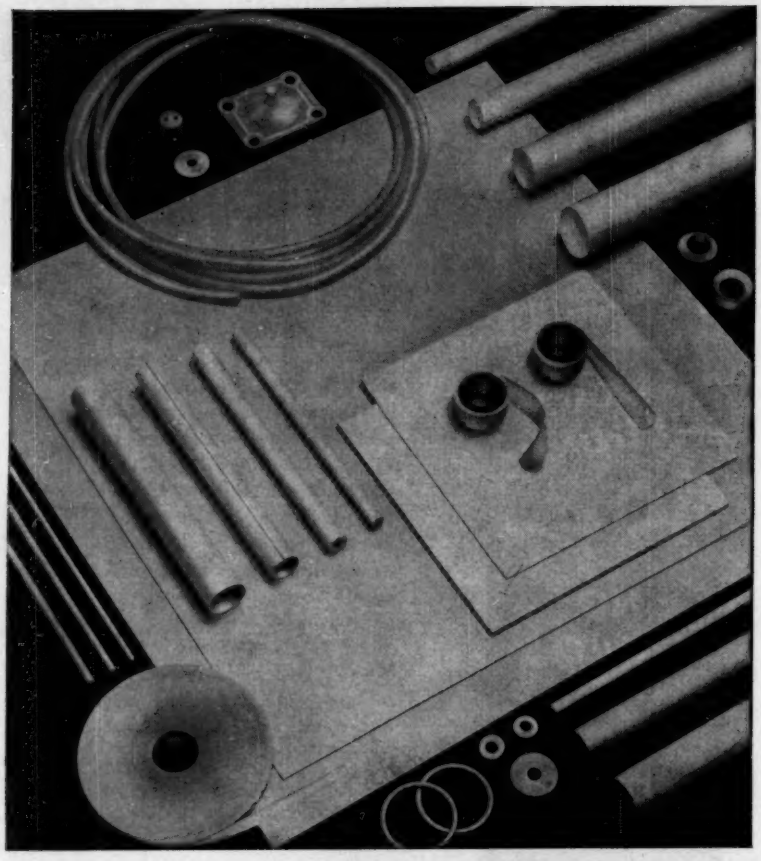
Indexing leaves something to be desired. Absolute fidelity to alphabetical listing may be proper in a dictionary, but I believe that an encyclopedia is more convenient to use if material is grouped by subject rather than alphabetically.

On the whole, cross-referencing of related articles within an article is excellent and once having read an article of primary interest, the reader should have no trouble finding all related material contained in these volumes.

They, however, are not meant for the scientific innocent. For proper understanding of the more technical article, the reader will require a solid grounding in higher mathematics and should have available a nuclear glossary.—PJB

Petrochemicals: The section on petrochemicals does a creditable job in outlining a tremendous field of chemical technology in just under six pages. The authors come to grips immediately with the peren-

Newark TESTING SIEVES
EXACT OPENINGS
NO CREVICES
STRONG DURABLE CLOTH
CLOTH RENEWABLE
If raw material control, laboratory testing or product control in your plant calls for accurate sieve testing, Newark's Standard Testing Sieves have a definite place in your plant. Made to conform with the latest specification of the National Bureau of Standards and the American Society for Testing Materials, these sieves are extremely accurate, and, as with testing instruments of all types, accuracy is of first importance. Newark Sieves are accurate because among other things the mesh is exact and there are no crevices to catch particles.
Newark Standard Testing Sieves are available in a complete range of sizes and we shall be glad to recommend the best range of meshes for your particular requirements.
U.S. STANDARD SIEVE SERIES
30
59
NEWARK
0232
NEWARK for ACCURACY
Newark Wire Cloth COMPANY
351 VERONA AVENUE • NEWARK 4, NEW JERSEY



Now you can do even more with TEFLON – made bondable by R/M

Time was, you'd often rule out "Teflon"* where it was sorely needed, simply because you couldn't make anything adhere to it.

But not now. R/M has perfected a process that makes "Teflon" easily bondable to other materials and to itself with commercial adhesives. Now you don't have to design intricate "Teflon" parts in a single piece or devise elaborate and costly fastening methods.

R/M can supply "Teflon" sheets and tape with bondable surfaces where you specify them. Thus you can use the remarkable electrical and chemical properties of "Teflon" without worrying about how to make it stay put. In fact, you can take advantage of bondability and non-bondability in the same R/M "Teflon" part.

A lot is happening in "Teflon" daily. To keep up with it, talk "Teflon" with the R/M man—learn of R/M's *complete "Teflon" service* that can help you improve design and increase reliability even while cutting costs. Call one of the offices listed below or write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

*Du Pont trademark for its TFE-fluorocarbon resin

R/M

PLASTIC PRODUCTS DIVISION
RAYBESTOS-MANHATTAN, INC.
Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2
HOUSTON 1 • LOS ANGELES 58 • MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3
PITTSBURGH 22 • SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

nial problem—just what is a petrochemical—and inform the reader that many petrochemicals come from nonpetroleum sources. The neophyte quickly becomes as confused as everyone else is on that point and can then proceed.

Four "road map" charts are presented that trace the various synthesis routes that can be traveled, after starting with methane, ethylene, propylene, the butylenes, or aromatic raw materials. Although the charts include only the large-volume chemicals, and some of the newer processes are not shown, still they furnish a good capsule view of a huge industry. Several tables are also provided that give the annual production rates of some of the major petrochemicals.

Because of space limitations, the authors do not get into the technology of petrochemical production. Readers seeking process data will have to look elsewhere.—RAL

Rubber: A necessarily brief, but complete and up-to-date picture of the field's fast-moving technology is presented in the nine-page entry on rubber.

Emphasized is the still-mounting importance of synthetic rubbers, including that recent commercial triumph, the duplicate of the natural rubber molecule. Characteristics, processing and compounding steps common to most rubbers are reviewed, as is the role of physical testing in rubber technology.

There follows an easy-to-grasp treatment of all rubbers already or about-to-be of commercial importance: natural, SBR, neoprene, butyl, nitrile, Thiokol polysulfide, silicone, Hypalon, polyurethane, polyisoprene, polybutadiene and adduct rubbers. For each, distinguishing chemical constitution, chemical and physical properties and commercial methods of manufacture are described. Current and comprehensive lists of end uses, including commercially available physical forms, are presented without elaboration.

A flow chart adequately illustrates SBR manufacture, and molecular structures of most types of rubber are depicted.—FA

Sulfur: The section on sulfur is

quite extensive, containing over two pages on the element itself and seven pages on sulfur compounds (not counting entries elsewhere in the encyclopedia that are listed under compound names). But it will be more useful to scientists than to engineers, because emphasis is on physicochemical aspects rather than commercial or technological information.

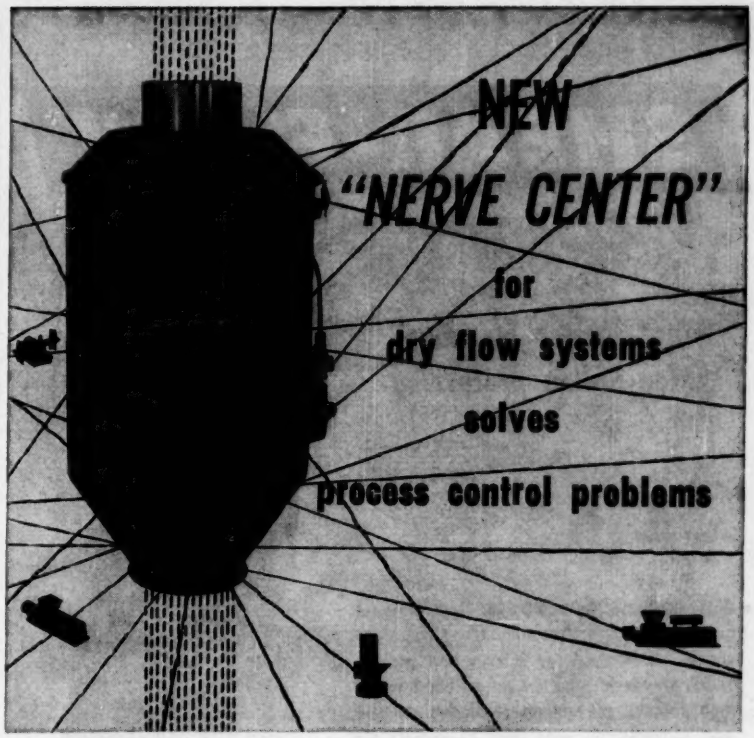
Discussion of the element includes its natural occurrence, preparation, physical and chemical properties, and uses. Former two subjects and the physical properties are covered fairly well, but the information on chemical properties and uses is sketchy.

Among the sulfur compounds covered are various sulfides, oxides, and oxy acids and their salts or esters. Features in this section include (1) a good, concise discussion of sulfuric acid and (2) a table showing name, formula, probable structure and known forms (acid, salt, ester, halide and amide) for 16 oxy acids of sulfur.—NPC

Synthetic Fibers and Plastics: Although lacking on such important topics as reaction kinetics, thermodynamics and process equipment, the sections on synthetic fibers and plastics cover all the fundamental principles of this branch of organic chemistry, which in itself would require thousands of pages for adequate coverage.

By plunging directly into the most commonly known resins and fibers and then working its way up to the least known compounds, this section gives a quick and informative review to chemists, students and rusty engineers, but the language remains simple enough to be understood by the layman who has had an inkling of chemistry.

Coverage of condensation and addition-type polymers runs the gamut from polyurethane, polyamide, polyester and silicone resins to polyacrylate, acrylonitrile, polyvinyl and polyolefin resins. In addition, these sections perform a task that is seldom attempted in organic chemistry textbooks because the reader can get a concrete perspective on such things as production figures, uses and economic significance of these products.—EG



The new W&T Massometer® senses flow in closed systems. It measures dry, free-flowing materials and translates the results into a 3-15 psi signal. The unit can be used to indicate or record. It also controls proportional blending . . . helps solve problems in all kinds of control situations.

And the Massometer does all this without breaks in your closed system. Air-tight construction means a flow-sensing unit that seals dust in . . . seals contamination out. It is compact and easily installed, fits neatly into the line. Stainless steel for parts exposed to the flow stream and dust-tight motor casing assure years of maintenance-free service.

The Massometer is calibrated with any maximum output between 40 and 200 lbs. per minute. Maximum volumetric capacity is 6 cubic feet per minute. Repeatability within ±0.2% of full scale assures stable performance.

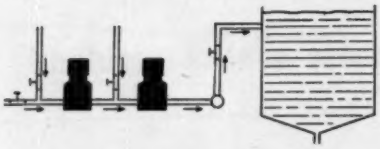
By generating a signal proportional to flow, the W&T Massometer brings a new look to ratio control. Its versatility means more accurate batch processing, or helps create continuous processing in new or existing systems.

For information, write Dept. M-50.29.

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

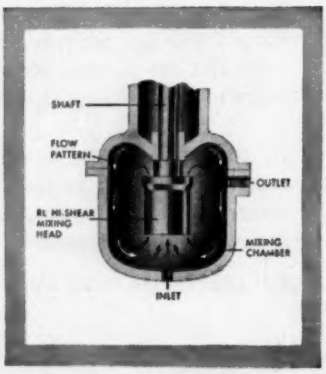
NEW SHEAR-FLOW CONTINUOUS MIXER

Finer, faster blending for in-line processing



- **CUT PROCESSING COSTS:** This compact and completely self-contained unit conserves space, eliminates large mixing and paddle tanks, speeds up pipe line processing, handles high viscosity material in a minimum of time and conveniently lends itself to systems requiring jacketed heating or cooling.
- **ELIMINATE COSTLY EQUIPMENT:** Incorporating the same design principle as the portable SHEAR-FLOW, the new continuous mixer is capable of mixing any liquid that can be pumped, with results better than or comparable to that of equipment costing considerably more.
- **VERSATILE ADAPTABILITY:** More than one unit can be installed in series or in tandem along the route of flow. The new continuous SHEAR-FLOW can also be mounted either vertically or horizontally.
- **HI-SHEAR HEAD:** The unique Hi-Shear Head with dual impellers and stationary stators creates a high turbulence and concentrated shearing action that results in finer, faster blending, homogenizing, emulsifying or dispersing. Mechanical shear is achieved through close tolerances between impellers and stators.
- **SIZE RANGE:** The new SHEAR-FLOW can be powered with motors ranging from 1 to 10 horsepower depending on the power requirement demanded by the application.

Write for free Bulletin No. RL-200



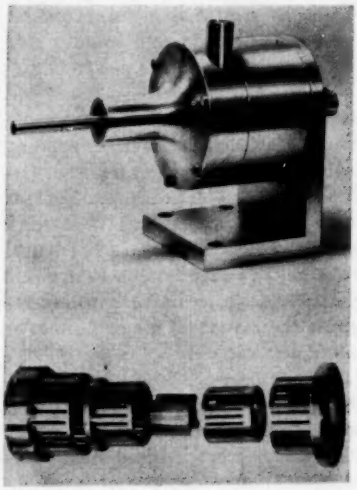
SHEAR-FLOW
GABB SPECIAL PRODUCTS INC.

GABB SPECIAL PRODUCTS INC.
Windsor Locks, Conn.

(continued from page 72)

machine deliver mono- or polyfilament yarns of precise denier. For polymer melt operations, the spinning head is heated automatically in three separate sections to maintain a low level of polymer degradation while extruding at a precisely adjusted temperature. Three standard spinnerette designs permit a variety of investigations.

For experimental solution spinning, an auxiliary yarn cover and plenum are available. Suitable openings are provided for hot-air introduction and solvent removal. Minor modifications can convert the cover and plenum into a chilled-air unit. — **Chemtex, Inc., New York.** **72D**



Mixing pump

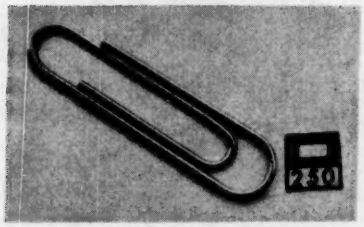
Unit blends wet and/or dry products from 5 to 200 gpm.

Shearing through material at least 750,000 times/min., a new continuous-flow mixing pump is designed to continuously blend wet with wet or wet with dry products. Called Shear Pump, it consists of rotors and stators that can be varied in any number of combinations depending on the product requirement.

According to the manufacturer, there is no aeration, although it can be incorporated into the unit

if needed. Uniformity of particle size is achieved by a control valve on the outlet line.

Unit may be cleaned in place, is easily disassembled. Blending feature is combined with a centrifugal pumping action that develops a suction lift and a discharge head. Units range from 5 gpm. for laboratory service to a 200-gpm. production unit. — **Hobam Inc., Buffalo.** **154A**



Temperature indicator

Tiny label turns black at desire temperature.

Measuring only ¼-in. square, this hermetically sealed plastic adhesive tab changes color when its temperature reaches any preset value from 100 to 500 F. Accuracy is ± 1%.

Small size makes it useful for miniature electronic components and inaccessible machinery areas. It sticks on just about everything, is impervious to almost all atmospheres.—**Pyrodyne, Inc., Los Angeles.** **155A**

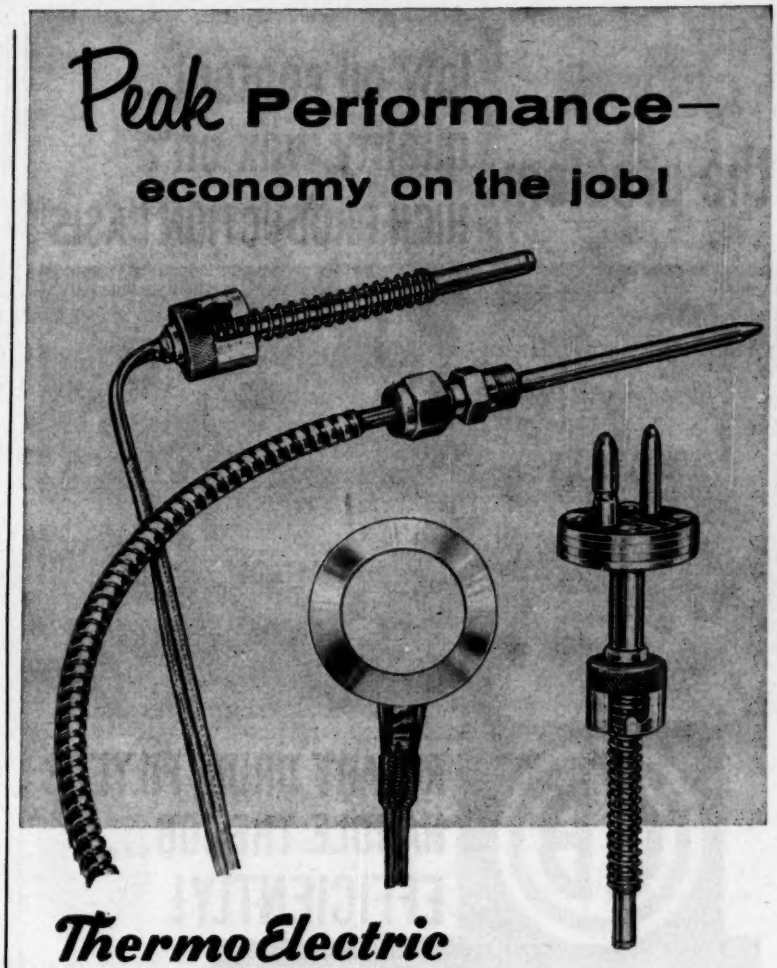
Rustproofing paint

Metallic coating is just as effective as galvanizing.

Ten years of research, a British firm reports, have paid off at last with a liquid that rustproofs iron and steel.

The rustproofer is a jelly-like paste that liquefies on the paintbrush but solidifies on steel within six hours, must be mixed on site. The mixing components are a heavy metallic gel and a liquid solidifier.

Two coats of rustproofer are re-



ThermoElectric

Miniature Thermocouples

You can obtain a Thermo Electric Miniature Thermocouple for peak performance and economy in almost every application! Those illustrated are available in a wide variety of sizes, standard thermocouple materials, adapt to many applications.

Protected thermocouples are extremely sensitive, give fast response to minute temperature changes. The measuring junction is welded or silver soldered to the tip of the thin-walled "Ceramo" metal sheath. Ideally used in corrosive liquids or gasses—and many pressure applications. For quick-coupling versatility, the spring-loaded bayonet-lock thermocouple is tops! You can use one "couple" at various depths with different adapters. With spring-loading, tip contact is always maintained. The bayonet type is highly sensitive, fast responding, for use in pump and engine cylinder heads, turbine housings, pipes, electric motors, generators, plastic extruders and molding machines.

Gasket Thermocouples measure surface temperatures in all sorts of stationary or moving machinery.

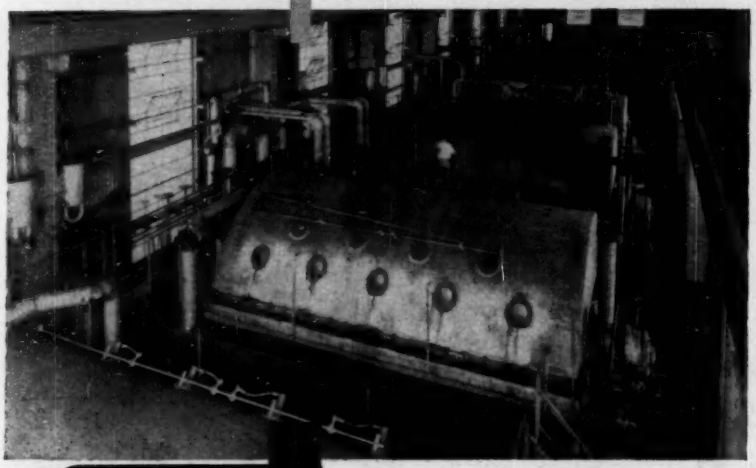
T.E. also produces stagnation, exposed junction and shielded thermocouples for use in air, gas or vaporous atmospheres.

write today for Bulletin 1256-4

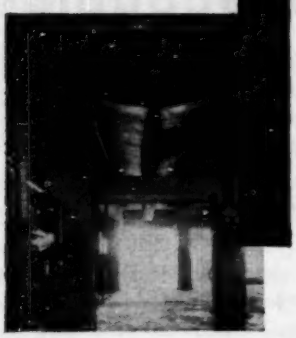
Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

the problem: low oil content quality wax on a HIGH PRODUCTION BASIS



ROTARY DRUM FILTERS HANDLE THE JOB... EFFICIENTLY!



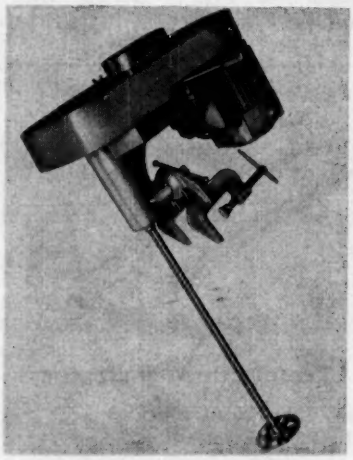
High efficiency is obtained with this G-B filter system for Mobil Oil Company at its Beaumont, Texas Refinery. These units feature a self-contained variable speed drive, efficient modern lighting and sight glasses, 2" and 3" FOAMGLAS insulation for low temperature operation. Fine quality parrafin wax of low oil content is obtained on a high production basis.

G-B filters are customed designed to meet your specific need. Write for more detailed information.

See our insert in Refinery Catalog and CEC.

GOSLIN-BIRMINGHAM
MANUFACTURING CO., INC.
P. O. BOX 631 BIRMINGHAM, ALABAMA
FILTERS • EVAPORATORS • PROCESS EQUIPMENT • CONTRACT MANUFACTURING including HEAVY CASTINGS

quired to protect bare metal; but if decorative paint is to be applied as well, then one coat of rust-proofer is sufficient. Product can be brushed onto damp metal, doesn't settle. — **Metalife Liquid Metals, Ltd., Harrogate, Yorkshire, England.** 155B



Portable agitator

Variable speeds are delivered with fixed-speed motor unit.

Out of an explosionproof, single-speed motor come speeds ranging from 260 to 4,000 rpm., in a unit that agitates, disperses, thins and mixes pastes and liquids.

Agitator incorporates a patented dispersion disk impeller and a 2-hp., 1,750-rpm. motor with a stainless steel agitator shaft. A cast-aluminum double-clamp bracket with ball and socket joint makes for easy vertical and sidewise angle adjustments. The unit sells for slightly more than conventional fixed-speed agitators.— **Patterson Foundry & Machine Co., East Liverpool, Ohio.** 156A

Waste filtration plant

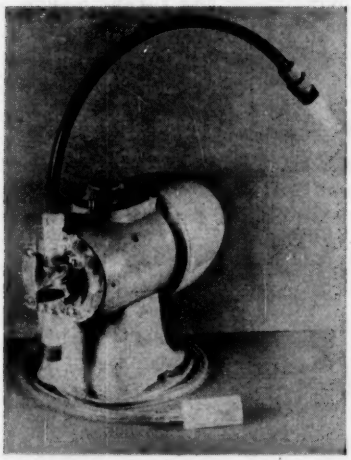
Living organisms remove many different types of wastes.

Food processing wastes, or any industrial waste that does not contain materials toxic to bacteria,

can be cleaned up by a new filtration plant that's said to produce clear and odorless effluent with one pass. The waste materials become food for the hungry organisms, which thrive on the diet as long as plenty of oxygen is available with the waste.

In operation, sewage or waste is pumped from a primary settling tank to top sections of the filter tower. Filter media, containing the bacteria, are arranged in layers with space between them. Into the spaces, and countercurrent to the downward flow of liquid, air is blown to maintain the oxygen level in the tower. Waste becomes increasingly cleaner as it flows down, until clear effluent is recovered at the bottom.

According to the manufacturer, filter can remove up to 6 lb. of B.O.D. solids per day per sq. ft. of filter area. This is considerably higher capacity than that obtained with either a standard trickling filter or an activated sludge removal system of the same size.—**Project Fabrication Corp., College Point, N. Y.** **156B**



Solution feeder

Electric device injects solutions into systems.

Designed to introduce small amounts of chemical solution into a water system, this electric, noncorrosive feeder finds applications

True balanced vapor-pressure! That's why NICHOLSON STEAM TRAPS increase Thermal Efficiency . . . and Here's How!

When live steam contacts the bellows of a Nicholson Trap, the pressure inside the bellows equals the pressure outside. With both pressures balanced, the spring action of the bellows closes the trap. When condensate collects around the bellows, pressure inside drops causing outside pressure to compress the bellows and open the trap.

Briefly, this is true balanced pressure and is the operating principle of Nicholson Thermostatic Steam Traps. That's why they discharge condensate and air quickly, positively and intermittently . . . and why they help you get full thermal value from every pound of steam and full productive value from your steam equipment. They provide greater capacity, too . . . up to six times that of ordinary traps. And there's no steam waste either, because seats and valves are of hardened stainless steel, finely ground and accurately lapped for sure, tight shut-off.

As for maintenance, it's practically nil . . . and here's why. In this simply designed trap there is only one moving part. No links, pins, pivots or levers to go wrong. No adjustable orifices to stick, wear or become clogged. No need for valve and seat changing. In short, no downtime because of trap failure.

Naturally, plus efficiency like this does not come at "bargain" prices. You can get cheap traps, of course. But remember this: *price* only shows up on the dealer's shelf; *value* is what shows up on your lines . . . and with Nicholson Traps it shows up in discharge action you can rely on to keep temperatures high and even for full thermal efficiency at point of steam use . . . efficiency that can often increase production as much as 20%.

This is low trap cost, where it really counts. Let's tell you more.

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Offices in principal cities

Send for Catalog

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Please send a copy of Catalog #400
NAME_____
COMPANY_____
STREET_____
CITY_____ **STATE**_____

DENVER Equipment

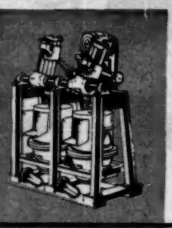
FOR THE CHEMICAL PROCESS INDUSTRY

DENVER AGITATORS AND MIXERS

Agitator types available: Turbine-type propeller (to 120" in tanks to 50' dia.), slow speed, high speed, air lift, vertical turbine mixers, mixer-settler units.

Write for Bulletin No. A2-B2

Lab and pilot scale agitators in LG3-B10

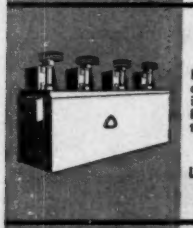


DENVER DIAPHRAGM PUMPS

Stroke can be adjusted while pump is operating. Long wearing nylon-reinforced rubber diaphragm. Sizes 1" to 10" simplex and duplex, capacity to 1000 g.p.m.

Write for Bulletin No. P8-B12

Lab and pilot scale diaphragm pumps in LG3-B10

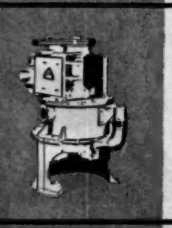


DENVER ATTRITION SCRUBBERS

High power input to efficiently remove sand coatings, mix dense slurries. Rubber lined or acid-proof tanks. Sizes to 56"x 56"

Write for Bulletin No. A-8305

Lab and pilot scale scrubbers in LG3-B10

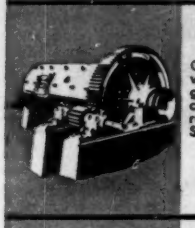


DENVER VERTICAL CENTRIFUGAL PUMPS

For handling frothy liquids or coarse, sandy slurries, constant or intermittent flow. No packing gland or sealing water. Standard or stainless steel construction. Capacity to 450 g.p.m.

Write for Bulletin No. P10-B5

Lab and pilot scale vertical centrifugal pumps in LG3-B10

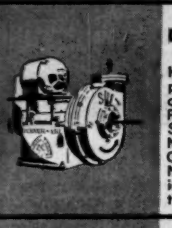


DENVER BALL AND ROD MILLS

Offer operation and convertibility. Wet or dry grinding systems. All steel construction. Ceramic or rubber linings available. Sizes to 10'x 20'.

Write for Bulletin No. B2-B20

Lab and pilot scale mills in LG3-B10



DENVER SRL (RUBBER LINED) PUMPS

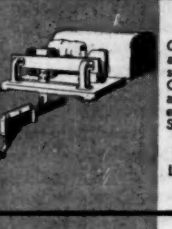
High efficiency, low horsepower. Parts last longer, cost less. Rubber lined. PUMPS AND PARTS IN STOCK. Sizes to 5000 g.p.m. Now available in "TRU-GLANDLESS" construction. No sealing water. No packing glands. No slurry dilution. **Bulletin P9-B28.**

DENVER JAW CRUSHERS

Cast steel frame, anti-friction side bearings and bumper bearings. Manganese steel jaw and cheek plates. Sizes from 2¼"x 3½" to 36"x 48".

Write for Bulletin No. C12-B12

Lab and pilot scale crushers in LG3-B10



DENVER SAMPLERS

Continuous mechanical and automatic types for dry, solution or slurry sampling. Complete sampling plants and sample processing equipment. SAMPLERS IN STOCK.

Write for Bulletin No. S1-B4

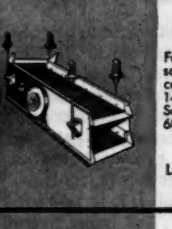
Lab and pilot scale samplers in LG3-B10

DENVER REAGENT FEEDERS

Both wet and dry feeders available. Let us know your requirements. Many standard units in stock.

Write for Bulletin No. F6-B8

Lab and pilot scale feeders in LG3-B10

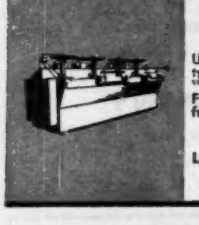


DENVER-DILLON SCREENS

For efficient wet or dry screening. "True-Circle" eccentric action. Sizes to 6'x 14' in stock. Also Trommel Screens in sizes from 30"x 60"x 120".

Write for Bulletin No. S3-B15

Lab and pilot scale screens in LG3-B10



DENVER "SUB-A" FLOTATION

Universal tank with three types of mechanisms: (a) "Cell-to-Cell"; (b) "Free-Flow"; (c) Type "M". Sizes from 16"x 16" to 72"x 72".

Write for Bulletin No. F10-B86

Lab and pilot scale flotation in LG3-B10

DENVER SPIRAL RAKE THICKENERS

Move settled materials to center in one revolution. Simple, efficient, heavy-duty gear mechanism for thickeners to 150' dia. Acid proof construction available.

Write for Bulletin No. T5-B6

Lab & pilot scale thickeners in LG3-B10

DENVER EQUIPMENT COMPANY

Box 5268, Denver 17, Colorado

Phone CHerry 4-4466

SEE OUR CATALOG ON PAGES 949-956 IN C.E.C.

DENVER TESTING FACILITIES

You will have problems in crushing, grinding, settling and possibly concentration and filtering. These are our specialties so please let us help you in our Test Department. Deco flowsheets are reliable and proven.

NEW EQUIPMENT . . .

in cooling towers, neutralization and chlorination reactions, H_2S-odor control, other areas.

Features: adjustable feed rate (from 2.4 to 20 gal./day), wide pressure range without antisiphon valve (from suction to 100 psi.), heavy-duty 115-v. motor.

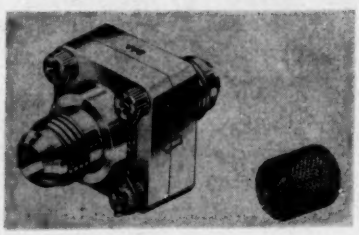
High-impact-plastic construction of all exposed parts makes for outdoor as well as indoor operation. Easy to install, the feeder can be mounted horizontally or vertically in less than 1 sq. ft.—**Bruner Corp., Milwaukee.** 157A

Wet test meter

Unit measures gas flows, is accurate to ± ½ of 1%.

To withstand corrosive effects of acid-laden gases, this wet test meter features cast-aluminum housing, epoxy-resin-plated interior. On-the-spot servicing by the operator is made possible by a new removable back.

Operable pressure range is 0.018 psi. to 15 psi.—yet even at pressures as low as 0.018 psi., accuracy is ±0.5% of gas volume. Thermometer and U-tube manometer are positioned on the meter's face. Two models are available; one handles 20 cu. ft./hr., the other 680 l./hr.—**Precision Scientific Co., Chicago.** 158A



Tiny filter

Assembly for fluid-line systems takes caustics.

This lightweight, miniature filter assembly can handle caustic or corrosive liquids and gases up to 2,260 psi. and 500 F.

Approximately 1¼ in. square and 2 in. long, the unit is all stainless steel except for an enclosed, inert Teflon washer that seals the body's two halves. The filter element is a conical stainless-steel mesh, providing 1.2 sq. in. of filter surface, of which half is open flow area. Laminar flow around and through the screen makes for minimum pressure drop.

The assembly is immediately available in two sizes: for ¼- and ⅜-in. tubes. Other sizes can be made to customer specifications, from any desired material compatible with flow media and temperature limitations.—**Dumont Engineering Corp., Long Beach, Calif.** 158B

Briefs

Position indicator provides continuous meter reading for up to 10 ft. of mechanical travel or fluid level. High and low contacts may be used for actuating warning devices. Unit uses magnetic coupling and Wheatstone bridge principle for operation. — **Gems Co., Inc., Farmington, Conn.** 159A

Moisture monitor measures ppm. of water in hydrogen electrolytically. Instrument overcomes error introduced by oxygen recombination with hydrogen by taking readings at two different flow rates, adjusting results to eliminate recombination factor. Accuracy is said to be within 5% of full-scale reading. — **Consolidated Electrodynamics Corp., Pasadena, Calif.** 159B

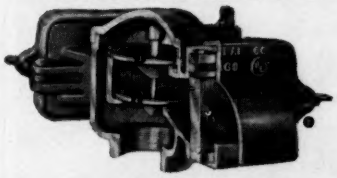
Atomizing nozzle produces a very fine, uniformly atomized solid-cone mist in capacities up to 330 gph. Available in bronze, stainless steel or special metals, it comes in orifice sizes from 2 to 6 mm. — **Schutte & Koerting Co., Cornwells Hgts., Pa.** 159C

Aluminum electrical fittings contain less than 1% copper, are ideally suited for use in corrosive

Protectoseal conservation Vents incorporate unique design and operating features to ensure optimum service on flammable or hazardous liquid storage tanks of every type.

● FLAME ARRESTER DESIGN

Vertically mounted rectangular plate type flame arrester structure is *outside* the housing. Advantages:



1 Pressure tight Aluminum alloy casting
2 Wing Nut on Swing Bolt
3 & 4 Pressure and Vacuum Relief Valves
5 Flame Arrester Structure

1. In the event of fire, the vent burns *at the arrester*, rather than at the valves. This eliminates heat warping or distortion of the valve mechanism.
2. Dirt and other foreign particles cannot reach valves, to cause improper seating.
3. Flame arrester is exposed to corrosive vapors on exhale cycle only. This keeps arrester plates clean longer, requires less maintenance.
4. Self-drainage of condensate.

The interchangeable flame arrester structure is made of heavy gauge metal to resist damage, bending or warping. Accurate, positive air-spacing assured upon re-assembly by embossings on the face of each plate.

A spare arrester can be inserted to safeguard tank interior while original arrester is being cleaned and serviced. Loosening wing nut and pushing swing bolts aside permits quick, easy removal of flame arrester structure.

Pressure and vacuum relief valves in Protectoseal Conservation Vents may be fabricated to relieve at settings required by your operating conditions. When severe corrosion is present, the vent housing, valves, and flame arrester structure may be fabricated from special corrosive-resistant metals. Teflon valve seats may also be provided.

Conservation Vents are made in a range of sizes to meet virtually any requirement. UL and FM approved.

OTHER PROTECTOSEAL EQUIPMENT FOR STORAGE TANK OPERATION

End-of-Line Flame Arrester Vent

In-Line Flame Arrester Vents

Steam Jacketed Vent with Flame Arresters

Combination Fill and Vent Units, Fill Units

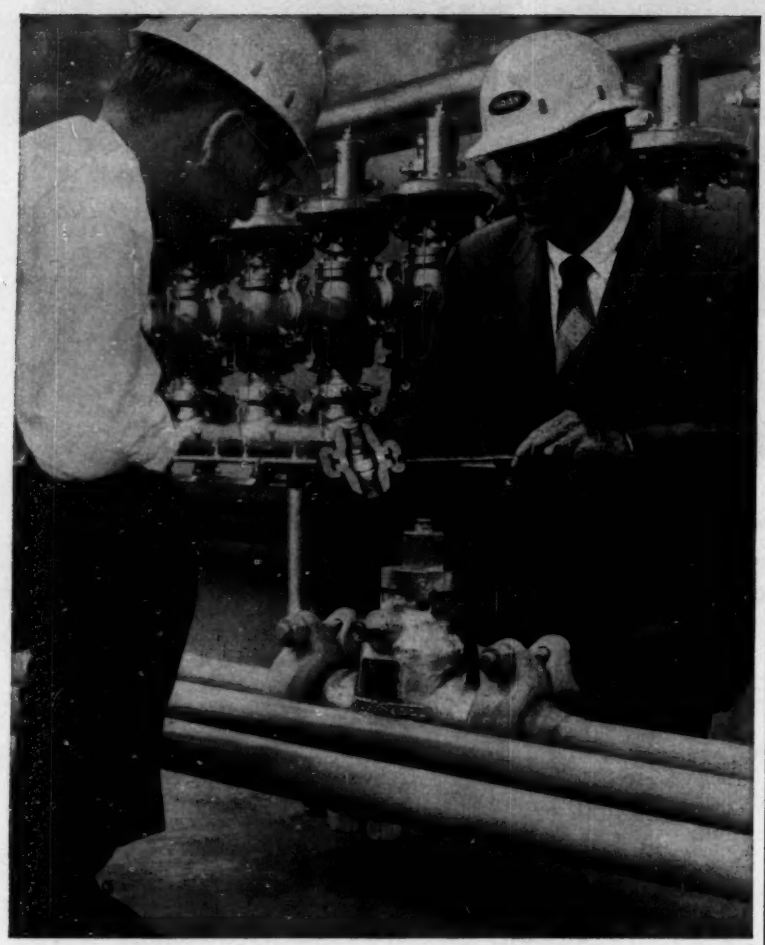
Combination Vent Rodding and Sampling Units

Emergency Relief

Write for the Protectoseal Blue Book. Illustrates and describes complete line of Protectoseal Products for hazardous liquid storage tank application.

THE PROTECTOSEAL COMPANY
1948 SOUTH WESTERN AVE. • CHICAGO 8, ILLINOIS

IN CANADA: Safety Supply Company, Toronto



GRAYLOC® Seal: Leak-proof at any pressure

Leak-proof quality of GRAYLOC Seals in piping applications has been use-proved from full vacuum to 30,000 psi and test-proved up to 150,000 psi. Holding at any pressure makes GRAYLOC practical in applications requiring positive leak-proof connections.

The GRAYLOC Seal is available in two-bolt clamp-type or conventional flange connections. Its simple steel design features a rigid rib with lips on either side tapering slightly less than the mating hub to form a line seal at the touchpoint. As the connection is tightened, the lips deflect to form a surface seal. GRAYLOC connections provide a permanent steel seal that can be made up repeatedly, operating to pressure without seal ring replacement. Stock connections available from ½" to 30" and on special order in corrosion-resistant metals.

If you want to know more about how GRAYLOC Connections can permanently solve your leakage problems, write for the new GRAYLOC CATALOG on your company letterhead.

GRAYLOC SALES DIVISION

GRAY Tool Company

P. O. BOX 2291 HOUSTON 1, TEXAS Riverside 7-1240 05

environments. Used with either ferrous alloy or aluminum conduit, fittings form a natural coating of aluminum oxide, which if destroyed by abrasive action will immediately re-form. — **Appleton Electric Co., Chicago.** **159D**

Filter unit traps particles down to 0.1 micron from liquids, using a porous plastic sheet with uniform submicron holes. The spongelike membrane is held in a metal assembly, supported by a sintered stainless steel plate. Sized for pressures of 50, 100 and 500 psi., filter holder comes in stainless steel or nickel-plated bronze.— **Gelman Instrument Co., Chelsea, Mich.** **160A**

Drum warmer, a flat heat-transfer unit rolled to fit the contour of a 55-gal. drum, immerses in liquids for rapid heating. Available in either serpentine or header construction, it has inlet and outlet connections that extend outside the drum. — **Tranter Mfg., Inc., Lansing, Mich.** **160B**

Equipment Cost Indexes . . .

	Sept. 1960	Dec. 1960
Industry		
Avg. of all	237.4	237.3
Process Industries		
Cement mfg.	231.7	231.6
Chemical	238.6	238.2
Clay products	225.6	225.1
Glass mfg.	225.3	224.8
Paint mfg.	229.1	229.4
Paper mfg.	229.9	229.4
Petroleum ind.	234.0	234.3
Rubber ind.	237.9	237.1
Process ind. avg.	236.2	236.7
Related Industries		
Elec. Power equip	240.2	238.3
Mining, milling	240.0	239.5
Refrigerating	267.7	268.0
Steam power	224.3	224.5

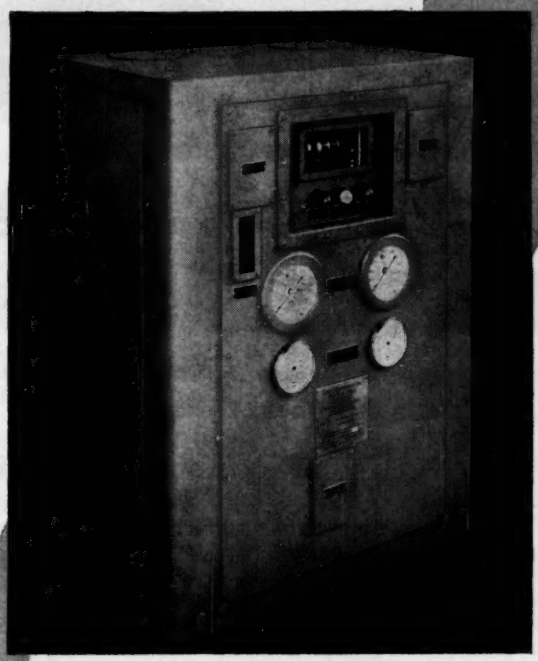
Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; April 4, 1960, pp. 149-50 for annual averages since 1913.

KEMP HIGH-PRESSURE DESICCANT DRYERS

assure specified performance 2 ways!

1 Engineering

Designed to dry air and gases under pressure (ranging from 1000 to 6000 psig) to dew points of -160° F, the Kemp High-Pressure Dryer is constructed for simplicity of operation and long life. It offers the advantages of: convenient location of instruments . . . no adjustment required from zero to 100% of rated capacity . . . contamination eliminated without purging . . . uniform and complete reactivation by electric heaters located for high efficiency and durability . . . welded steel seamless towers hydrostatically tested at 50% above design pressure.



2 Experience

Supplying dry air, helium or other gases for pressurizing rocket fuel systems, conveying rocket fuel, operating servo-mechanisms, wind tunnels and instruments, the Kemp High-Pressure Dryer has proved itself at many launching stations as well as research and industrial plants. This unit's reliability of performance under all circumstances reflects Kemp's solid background in these specialized applications.

For full details on Kemp High-Pressure Desiccant Dryers or any other Kemp Dryers, write for Bulletins D-108 and D-109 . . . or call your Kemp Man listed in the Yellow Pages and the *Chemical Engineering Catalog*.

It always pays to come to

KEMP OF BALTIMORE

THE C. M. KEMP MANUFACTURING COMPANY
405 E. Oliver Street • Baltimore 2, Maryland

Fall River Line Pier, Inc. installs new

TOLEDO ELECTRONIC TRUCK SCALE

with **PRINTWEIGH® "400"**

"speeds up weighing, provides accurate printed weights"
says William J. Torpey, General Manager

"Truck weights up to 50 tons are instantly transmitted *electronically* from the full-length 60′ scale platform to the weighing head located in the pier office. There, the weight records are automatically printed in triplicate on certified weight tickets. Our Toledo Printweigh "400" eliminates human error, speeds weighing and assures more accuracy than ever before on any scale, to trucker and customer alike."

TOLEDO's complete truck scale line gives you a full choice of capacities and platform sizes in mechanical or electronic type scales. Printweigh recording on forms, tickets or strips may be at the scale or a remote location. Many more advanced TOLEDO features are offered to speed weighing, eliminate human error. For full details, write for Bulletin 2417, TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio. (Toledo Scale Co. of Canada Ltd., Windsor, Ontario)

SERVICE Factory-Trained 240 Cities

TOLEDO®

Greatest name in weighing

Letters: Pro & Con

Con: CEQ Tests

Sir:

This is about your new feature, "Test Your CEQ." The problems and their solutions are indeed interesting, but I don't think they fulfill their purpose in *CE*. In contrast, your "*CE* Refresher" does fulfill its purpose; plenty of detailed problems take the reader by the hand in their solution.

Let's not forget the more basic but less fancy problems, like this one from my grammar school days:

A solvent tank can be filled by two feed pipes in 4 and 5 hr., respectively. Two drain-off pipes can empty it in 3 and 6 hr., respectively. If the tank is half full to start with, and if all valves are opened at the same time, will the tank be filled or emptied? How long will it take?

THOMAS GARCIA BORRAS
Cabot Corp.
Cambridge, Mass.

▶ *We're glad to see that some people working along Cambridge's famous "research row" still think in fundamental terms. Our answer: the tank will be emptied in 10 hr. Right?*—ED.

No Egg-zact Answer

Sir:

Your "CEQ" test on p. 207 of your Oct. 17 issue struck me as a little impractical. Surely the average hen egg weighs 2 oz. and if boiled for 8 min. is grossly overcooked, at least in this country.

The erudition of Prof. Lemlich encourages me to ask whether he could help with a problem of my distant youth. Together with a London medico and a lecturer on psychology, I was on kitchen fatigue with a youth group one early summer morning, and we had this problem: If it takes 4 min. to cook an egg when placed in a pan of boiling water, how long does it take to cook sixty? Our arguments ranged over the time interval of 4 min. to 4 hr. Eventually we cooked the eggs for 12 min. It took 2-3 min. to get them

in and rather longer to get them out; those at the bottom were hard, and those that went in last were undercooked.

Could we have done better?

H. A. PIGGOTT
Cheadle Hulme
Cheshire, England

Sir:

I believe Mr. Piggott could have indeed done better. For example, he might have placed all these (presumably uniform) eggs in a simple basket of wire or cloth mesh and lowered them quickly into boiling water. After boiling for the desired period of time, the basket full of eggs would then have been quickly withdrawn and quenched momentarily in cool water to halt further cooking.

An alternative but somewhat less satisfactory method would be to put the eggs in a dry vessel, pour boiling water on top of them and then quickly place the vessel over the flame. After the desired boiling period has elapsed, the vessel is removed from the flame, most of the hot water quickly poured off and cool water added to quench.

The degree to which eggs are cooked varies widely. It covers the entire range from raw (for eggnogs) to thoroughly hard-boiled (for certain salads). Even breakfast preferences differ considerably from person to person.

Egg sizes vary also, some being smaller than 1 oz. However, I am not in a position to say if this holds for British eggs. Perhaps British hens have more talent.

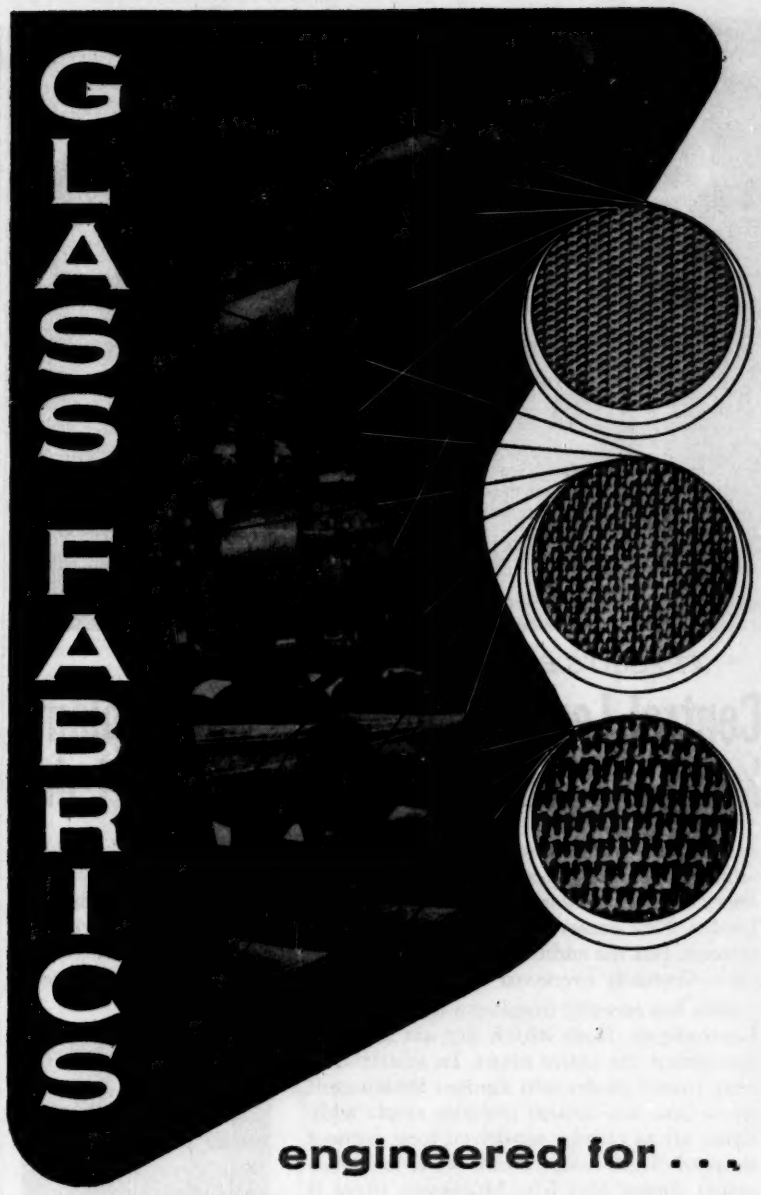
ROBERT LEMLICH
University of Cincinnati
Cincinnati, Ohio

Pro: Readable Book Reviews

Sir:

Thank you for sending me a copy of your splendid review of the second supplement to the "Encyclopedia of Chemical Technology." Your book reviews are so readable, and this was no exception.

Would you be kind enough to send me another copy of the review? I want the indexer to see



engineered for . . .

•LIQUID FILTRATION •PLASTICS LAMINATION

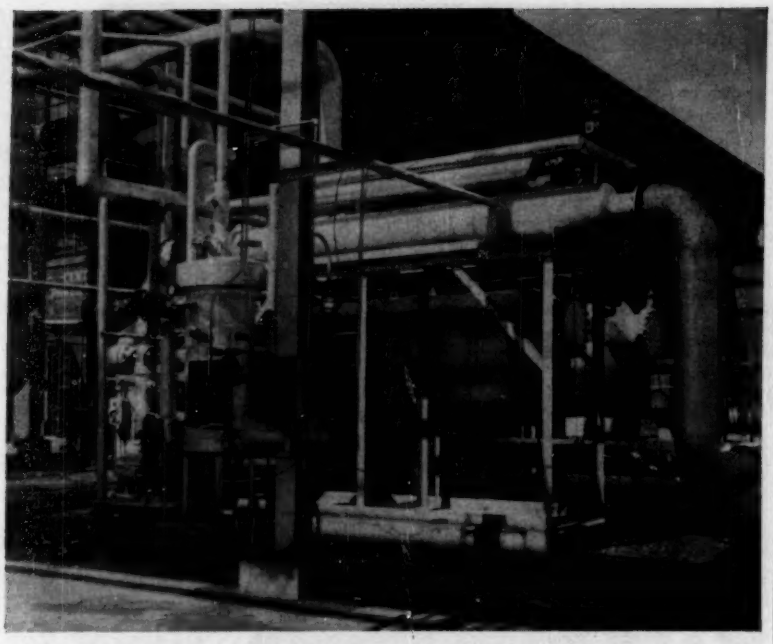
•HIGH TEMPERATURE DUST COLLECTION •INSULATION

Tell us your application, we will send you samples

Weavers of Industrial Filter Media for over Fifty Years

NFM NATIONAL FILTER MEDIA *Corporation*

General Offices and Mills: New Haven 14, Conn.: Western Office and Factory: Salt Lake City 10, Utah, Sales Offices—Representatives: Atlanta, Ga., 990 Lindridge, N.E.; Cleveland 39, Ohio, P.O. Box 9407; Alhambra (L. A. Area), California, 20 South 1st St.; Chicago, Ill., 6034 N. Cicero Avenue; Maquinaria Minera e Industrial, S.A.; Mexico, D.F., Apartado #215; Houston, Texas, 1607 Jefferson Avenue; Toronto, Ontario, C.P.R. Roadway, 1119 Yonge Street.



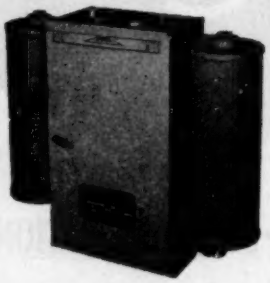
AT ESSO'S BAYWAY REFINERY...

Central Lectrodryer serves entire plant, keeps instrument and tool air desert-dry

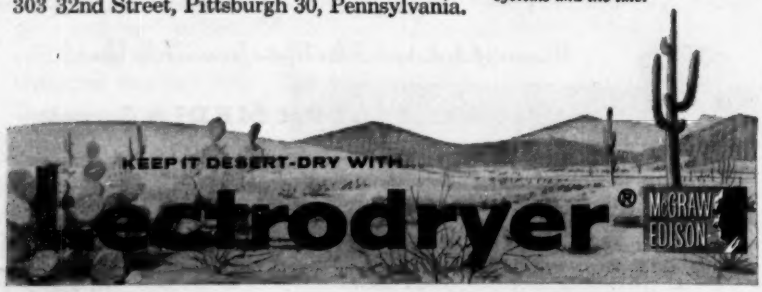
A steady flow of moisture-free instrument air is essential to smooth-running refinery operations. Lectrodryers have long been used at the Bayway Refinery of the Esso Standard Division of Humble Oil and Refinery Company, Linden, New Jersey, to control moisture content in individual instrument systems. But the addition of new instruments, more controls and air-driven tools eventually overtaxed the combined capacity of the individual dryers.

Esso has recently installed a single, central Lectrodryer, from which dry air is piped throughout the entire plant. In addition to year-round protection against instrument freeze ups, this system provides ample additional air to operate air-driven tools without the need of anti-freeze; means better tool lubrication, longer tool life. Moreover, there is neither air nor maintenance time wasted in bleeding lines dry.

Investigate the benefits of such a Lectrodryer system by writing for case history sheets illustrating in detail specifications and solutions to a multitude of moisture problems. Pittsburgh Lectrodryer Division, McGraw-Edison Co., 303 32nd Street, Pittsburgh 30, Pennsylvania.



Lectrodryer's wide range of drying apparatus also includes this budget model, which delivers small quantities of extremely dry air for wave guides, small cubicles, instrument systems and the like.



what you thought of this job. Indexers are unknown, self-effacing workers in the field of scientific communications, and it is very nice when one of them gets a public pat on the back.

ANTHONY STANDEN
Interscience Encyclopedia, Inc.
New York, N. Y.

Pro: Domestic Fluorspar

Sir:

Your article, "New Sources of Fluorine" (Dec. 12, pp. 79-80), implies that there is a dearth of CaF_2 in the U. S.

While there is much clamor among CaF_2 consumers about such a shortage, the fact is that there *is* CaF_2 here, and it can be produced (at high cost, it is true) in ample quantity.

A tariff or a quota (with real teeth in it) would support commercial CaF_2 from domestic ores. Millions of dollars are being spent to seek outside sources, when a tariff or quota on foreign CaF_2 ores would develop U. S. sources almost immediately and in ample supply. Let's try it!

J. BLECHEISEN
Rosiclare, Ill.

Hail From the Chief

Sir:

Someone recently sent me a copy of Dr. Parmelee's review of my book, "The Great Depression." The review was published in the Feb. 1953 issue of *Chemical Engineering.*

I just want you to know that it is a ray of sunshine in the murk of academic persiflage.

HERBERT HOOVER
New York, N. Y.

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. They'll be welcomed.

For more information . . .

- Advertised Products
- New Equipment
- New Chemicals
- Manufacturers' Literature

- Classified Advertisements

Also . . .
- Reprints orders
- Subscriptions

Your Reader Service card is fastest.

USE EITHER CARD

They're easy to fold and tear out . . . try it . . .

PLEASE PRINT *

NAME:
TITLE:
COMPANY:
NO. OF EMPLOYEES:
PRODUCT:
ADDRESS:
CITY, STATE:

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—POSTAGE WILL BE PAID BY—

Chemical Engineering
READER SERVICE DEPARTMENT
330 West 42nd St.
NEW YORK 36, N. Y.

PLEASE PRINT *

NAME:
TITLE:
COMPANY:
NO. OF EMPLOYEES:
PRODUCT:
ADDRESS:
CITY, STATE:

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—POSTAGE WILL BE PAID BY—

Chemical Engineering
READER SERVICE DEPARTMENT
330 West 42nd St.
NEW YORK 36, N. Y.

Help Yourself . . .

The postcards above can now bring you technical help, latest literature, expert guidance. Tear one out and, as you read this issue, circle numbers when you want more information. You'll note that the coding system is simple: all the code numbers are page numbers.

You can also use these post-paid cards to subscribe, or to make your selection from a comprehensive list of editorial reprints.

* Be sure to fill in all of these address blanks before mailing postcard.

3

Send CE for ☐ 1 yr. $3, ☐ 3 yr. at $5 (U.S. rate only.)

To _____

CIRCLE code numbers for more information. (This Feb. 6 issue card will expire May 6. 1961)

Cov	18	32	57	66C	71e	111	135	146	156	158i	160B	175	R182b	BR194
1	19	34	59	66D	72A	113	L136	147	156A	158j	161	T176	R182c	TL195
2	20	39	61	66E	72B	115	R136	148	156B	158k	162	B176	R182d	BL195
4	21	41	62A	66F	72C	117	L137	149	157	158l	163	176A	R182e	R195
6-7	22	45	62B	67	72D	119	R137	150	157A	158A	164	177	L183	TL196
8-9	23	47	63	68A	73	121	138	151	158a	158B	168	T178	R183	BL196
10-11a	24	49	64A	69	75	123	139	152	158b	159	168A	B178	L184	TR196
10-11b	25	51	64B	70A	80	125	140	153	158c	159A	169	179	R184	TL197
10-11c	26	53a	64C	70B	81	127	141	154	158d	159B	170	T180	L185	BL197
12	27	53b	64D	71a	82	128	142	154A	158e	159C	170A	B180	185A	R197
13	28	53c	65	71b	84	129	143	155	158f	159D	172	181	185B	198
15	29	53d	66A	71c	85	131	144	155A	158g	160	173	L182	L194	199
16	30	55	66B	71d	86	133	145	155B	158h	160A	174	R182a	TR194	200
17	31													

Circle KEY NUMBERS for more information about . . .

- ADS
- PRODUCTS page 62
- EQUIPMENT page 68
- SERVICES
- LITERATURE page 168

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

- CLASSIFIED

REPRINTS: Circle what you want. (See opposite page for description.)

40	42	43	49	50	52	54	55	57	59	61	62	63	64	66	67	68	70	72	73	74	75
76	78	79	80	81	82	83	85	86	87	88	89	90	91	92	94	95	96	97	98	99	100
101	102	103	105	107	108	109	110	111	112	113	114	115	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	133	135	136	138	139	141	142	143	144	145	146	147	148	149	150	151
152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	173	174

FREE REPRINT: Check here ☐ for your file copy of this issue's reprint (p. 112) FC 55

REPRINTS (While they last)

3

Send CE for ☐ 1 yr. $3, ☐ 3 yr. at $5 (U.S. rate only.)

To _____

CIRCLE code numbers for more information. (This Feb. 6 issue card will expire May 6. 1961)

Cov	18	32	57	66C	71e	111	135	146	156	158i	160B	175	R182b	BR194
1	19	34	59	66D	72A	113	L136	147	156A	158j	161	T176	R182c	TL195
2	20	39	61	66E	72B	115	R136	148	156B	158k	162	B176	R182d	BL195
4	21	41	62A	66F	72C	117	L137	149	157	158l	163	176A	R182e	R195
6-7	22	45	62B	67	72D	119	R137	150	157A	158A	164	177	L183	TL196
8-9	23	47	63	68A	73	121	138	151	158a	158B	168	T178	R183	BL196
10-11a	24	49	64A	69	75	123	139	152	158b	159	168A	B178	L184	TR196
10-11b	25	51	64B	70A	80	125	140	153	158c	159A	169	179	R184	TL197
10-11c	26	53a	64C	70B	81	127	141	154	158d	159B	170	T180	L185	BL197
12	27	53b	64D	71a	82	128	142	154A	158e	159C	170A	B180	185A	R197
13	28	53c	65	71b	84	129	143	155	158f	159D	172	181	185B	198
15	29	53d	66A	71c	85	131	144	155A	158g	160	173	L182	L194	199
16	30	55	66B	71d	86	133	145	155B	158h	160A	174	R182a	TR194	200
17	31													

Circle KEY NUMBERS for more information about . . .

- ADS
- PRODUCTS page 62
- EQUIPMENT page 68
- SERVICES
- LITERATURE page 168

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

- CLASSIFIED

REPRINTS: Circle what you want. (See opposite page for description.)

40	42	43	49	50	52	54	55	57	59	61	62	63	64	66	67	68	70	72	73	74	75
76	78	79	80	81	82	83	85	86	87	88	89	90	91	92	94	95	96	97	98	99	100
101	102	103	105	107	108	109	110	111	112	113	114	115	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	133	135	136	138	139	141	142	143	144	145	146	147	148	149	150	151
152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	173	174

FREE REPRINT: Check here ☐ for your file copy of this issue's reprint (p. 112) FC 55

REPRINTS (While they last)

For Subscriptions: To apply, check here.....

(Pay when billed) Where to send subscriptions.....

Want More Data?

Use either of these two postcards for catalogs . . . for more information or equipment . . . on materials . . . on advertised items . . . for helpful reprints of editorial articles. Be sure to fill out the other side of cards before mailing.

Why be just another name on a magazine outing list . . . when you can have your own copy of CE for less than a PENNY A DAY?

JUST A PENNY A DAY could have brought you the personal use of all the information in this issue. Just think . . . with your own copy of CHEMICAL ENGINEERING, there is no waiting for each issue to reach you and there is no need to hurry it along. You can clip articles for your files . . . the entire issue is yours, as personal as your newspaper.

Use this handy coupon to order your personal subscription to Chemical Engineering. *No need to send any money now. We'll bill you later.*

Reprints Now Available

CE editorial reprints are now easy to get—use Reader Service Card for fast service. For each reprint you want just circle its number on the card. Fill in the blanks on the front, mail. You may send remittance if you wish.

• Materials of Construction

Corrosion—Refresher on cause & cure ($1).....131
High-Temperature Materials—Inorganic, nonmetallic (75¢) 120
High-Temperature Metals—Selection, directory ($1).....129
Lead Installations—Best designs for many uses (50¢).... 79
Nonmetallic Inorganics—For severe conditions (50¢).....125
Plastic Pipe—How and when to use (75¢).....135
Protective Linings—Choice, application, directory ($1).... 88

• Equipment and Design

Air Pollution—CPI plant solutions (50¢).....143
Control Valves—Behavior and selection (75¢).....141
Estimating Engineering Properties
Thermal Conductivity (50¢) 94
Heat Capacities (75¢).109
Latent Heat (75¢)....117
Surface Tension (75¢).126
Viscosity (75¢) 138
Critical Properties (75¢).149
Other Physical Properties (50¢) 151
Flowsheets—Engineering communiques (50¢)..... 99
Flow File—50 design formulas (50¢).....112
Flow Through Packing and Beds
Packed Towers (50¢).....103
Fixed and Moving Beds (50¢).....107
Fluidized Systems (50¢).....108
Heat Exchanger Design—Shortcut methods (75¢)..... 52
Heat Exchanger Calculations—Use these charts ($1).....136
Instruments—"Hardware" section of Report 95 (50¢)..... 96
Mechanical Seals—How to select and use (50¢)..... 83
Piping—Roundup of process pipe, valves, fittings (75¢).... 40
Process Design: Fluid Flow—Size lines, pick pumps ($1)..161
Process Control—Instrumentation report ($1)..... 95
Pump Seals—Chemical plant practice (50¢)..... 92
Water Conservation—Will taps run dry? (50¢).....105
Water Pollution—Solve plant problems (50¢).....122
Your Design Reference File
Parts I-V (75¢).....100
Parts VVI-IX (75¢).....110

• Processes

Bio-oxidation—Treatment of wastes (50¢)..... 68
Chemicals from Petroleum—Available processes ($1).....139
Extractive Metallurgy—By chemical processing (50¢)....111
Ultra-Low Temperatures—Production and uses (50¢).....133
Fermentation—Its chemical technology (50¢)..... 74
High-Temperature Technology—Materials, processes (50¢). 91
Manufactured Gas—To supplement natural gas (50¢)....115
Moving Bed Processes—Theory plus application (75¢).... 64
Nuclear Industry—Role of chemical engineers (50¢)..... 89
Nuclear Wastes—Treatment and disposal (50¢).....150
Odor Control—How to be a good neighbor (50¢)..... 98
Operation & Maintenance—The impact of trends ($1)....121
Photochemical Engineering—Uses, processes, reactors (75¢) 59
Plants & Facilities—Inventory of 1959 (75¢).....158
Processes & Technology—Eighth Inventory 1958 (50¢)...118
Processes & Technology—Ninth Inventory 1959 (50¢)....159

• Costs and Commerce

Buyer-Seller Relations—Vendor's view (50¢).....157
Capital Cost Estimating—Data, sources & methods ($1)...156
CE Cost File—Quick estimating data (50¢).....153
Cost Control Systems—Reduce and control costs (50¢)....102
Inflation—How to predict a shrinking dollar (50¢)..... 78
Modernization—Tighten up for profits (75¢).....128
Patent Fundamentals—Timely review (50¢).....114
Petrochemicals—1958 economic review (50¢).....123
Process Energy—Make or buy? (50¢).....142
Professional Registration—For PE-Minded ChE's (50¢)... 85
Rockets and Missiles—Airborne reactor problems (75¢)...119
60's Challenge Chemical Engineers (50¢).....152

• Unit Operations

Absorption With Chemical Reaction—(50¢).....162
Adsorption—Design, methods, materials (50¢).....154
Azeotropic Separation—Close-boiler distillation (50¢).....160
Binary Distillation—Theory, equipment (75¢)..... 54
Compressible Fluids—How to handle ($1)..... 80
Crystallization—For purification (50¢).....124
Drying—Methods, equipment, design, costs (75¢)..... 70
Foams—How to use and control (50¢)..... 86
Ion Exchange—Process, design and applications (75¢).... 55
Liquefied Compressed Gases—Handle with care (50¢)....147
Liquid-Gas Contacting—A practical operation study (75¢). 82
Liquid Proportioning—Equipment, methods, uses (50¢).... 76
Lubrication—For chemical plant engineers (50¢)..... 50
Plant Startups—Systematic preparation (50¢).....165
Solids Concentration—Survey of techniques (50¢)..... 67
Solids-Gas Contacting—Commercial practice (50¢) 63
Solids-Liquid Separation—Unit operations description ($1). 62
Solid-Solid Blending—Theory, practice, equipment (75¢).163

• Chemical Engineering Science

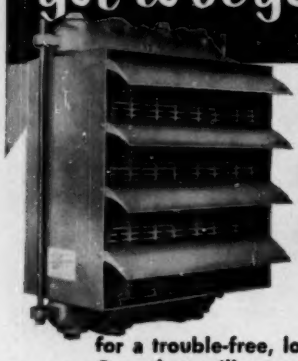
Analog & Digital Computers—In engineering use (50¢)...145
Speculative Process Design—Pilot plant bypass (50¢).....146
Pilot Plant—All the aspects of scale up ($1).....127
Statistics—How to use data effectively (75¢)..... 73
CE Refresher
Thermodynamic Principles (50¢)..... 42
Compression & Expansion (50¢)..... 45
Chemical Equilibrium (50¢)..... 49
Homogeneous Kinetics (50¢)..... 57
Catalytic Kinetics (50¢)..... 61
Interpreting Kinetics (50¢)..... 66
Simple Reactor Design (50¢)..... 72
Complex Reactor Design (50¢)..... 75
Catalytic Reactor Design (50¢)..... 81
Reactor Design Problems (50¢)..... 87
Physical Equilibrium I (50¢)..... 90
Physical Equilibrium II (50¢)..... 97
Fluid Flow Equations (50¢).....101
Fundamental Math (75¢).....113
Mass Transfer Operations ($1).....130
Unit Operations Refresher
Fluid Flow (50¢).....144
Sedimentation Theory (50¢).....148
Heat Transfer (50¢).....155
Unsteady State Heat Transfer (50¢).....164

Recent Reprints—to keep your files up-to-date.

Absorption Methods—Unit operation refresher (50¢). .168
Batch Distillation of Binary Mixtures (50¢).....174
CPI Forecast for '61 (50¢).....170
Conference on the New Chemical Engineering ($1.50)..173
Packaging—Unit containers for chemicals (50¢).....166
Plants & Facilities—Eleventh Inventory 1960 (50¢)...167
Processes & Technology—Tenth Inventory 1960 (50¢)..171

GRID's got to be good!

The best guarantee any product can have is its users.



LOOK at the plants that depend upon GRID

UNIT HEATERS
BLAST HEATERS
RADIATORS

for a trouble-free, low maintenance cost heating system - One that will serve without service - Installations made in 1929 are still operating without need for repairs. GRID'S design and construction makes the difference!

GRID — Cast Iron Construction resists corrosion externally from acid fumes and internally from electrolysis. No leaking from rotted cores.

GRID — one-piece cast iron heating sections and headers are leak-proof on steam pressure up to 250 p.s.i. 450° temperature. Smaller steam lines cost less.

GRID — heating sections with widely spaced fins cast integral with steam chambers are easy to clean - Will not "mat" on air intake side.

GRID — design develops low outlet temperatures and, with proper fan volumes, delivers warm, comfortable air to floor - No wasted heat at ceiling.

Get complete information on a GRID System for your plant. Write for catalog #956 GRID CAST IRON STEAM HEAT TRANSFER SURFACE.

Representatives in principal cities

ABBOTT LABORATORIES
BUCKEYE COTTON OIL CO.
DIAMOND ALKALI CO.
ANSUL CHEMICAL CO.
GIVAUDAN-DELAWANNA CORP.
HOFFMAN LA-ROCHE INC.
NATIONAL LEAD CO.
PENNSYLVANIA SALT MFG. CO.
CHAS. PFIZER & CO., INC.
HOOKER CHEMICAL CORP.
MONSANTO CHEMICAL CO.
NATIONAL ANILINE
NOPCO CHEMICAL CO.
DIAMOND CRYSTAL SALT CO.
NAUGATUCK CHEMICAL
E. I. DuPONT de NEMOURS, INC.
STAUFFER CHEMICAL
COLUMBIA SOUTHERN CHEMICAL CORP.
CHEMICAL & INDUSTRIAL CORP.
MINNESOTA MINING & MFG. CO.
HARSHAW CHEMICAL CO.
UNION CARBIDE & CARBON
VITRO MFG. CO.
AMERICAN CYANAMID
HERCULES POWDER
NICHOLS CHEMICAL CO., LTD.
BENZOL PRODUCTS
DOW CHEMICAL CO.
PENICK & FORD LTD.
SHARPLES CHEMICALS
CLIFFS DOW CHEMICAL CO.
REICHOLD CHEMICAL INC.
DAVISON CHEMICAL CORP.
DISTILLERS PROD. CO.
NATIONAL
OLIN MATHIESON CHEMICAL CORP.
KOPPERS CO. INC.
EASTMAN KODAK CO.
LITHIUM CORP. OF AM.
VICTOR CHEMICAL WORKS
AMERICAN VISCOSE CORP.
HOECHST CHEMICAL CO.
MERCK & CO., INC.
GENERAL ANALINE & CHEMICAL DIV.
HILTON DAVIS CHEMICAL CO.
SOUTHERN DYESTUFF CORP.
WITCO CHEMICAL CO.
ALLIED CHEM. & DYE CORP.
FOOD MACHINERY & CHEMICAL CORP.

D. J. MURRAY MANUFACTURING CO.
WAUSAU *Manufacturers Since 1883* WISCONSIN

Manufacturers' Literature

Contents of This Issue

Chemicals	168
Construction materials	170
Electrical & mechanical	172
Handling & packaging	174
Heating & cooling	174
Instruments & controls	176
Pipe, fittings, valves	178
Process Equipment	182
Pumps, fans, compressors	184
Services & miscellaneous	185

Chemicals

Acrylic Monomers.....Wide selection and efficient service for convenient low cost purchasing of acrylic monomers. Technical literature and samples are offered.
49 *Rohm & Haas

Alloys.....Hastelloy alloy C is one of 9 corrosion-resistant alloys. Resistant to fluorine gas as hot as 950 deg. F. Test samples are available on request.
131 *Haynes Stellite Co.

Asbestos.....Newly developed special grade of asbestos fiber for use as a reinforcing agent in plastic molding is described in technical bulletin that contains physical characteristics.
168A Johns-Manville

Chemical.....Pureco CO2 is a versatile chemical used for many different applications. It may be used as a refrigerant, gas or an ingredient for carbonates. Information.
59 *Pure Carbonic Company

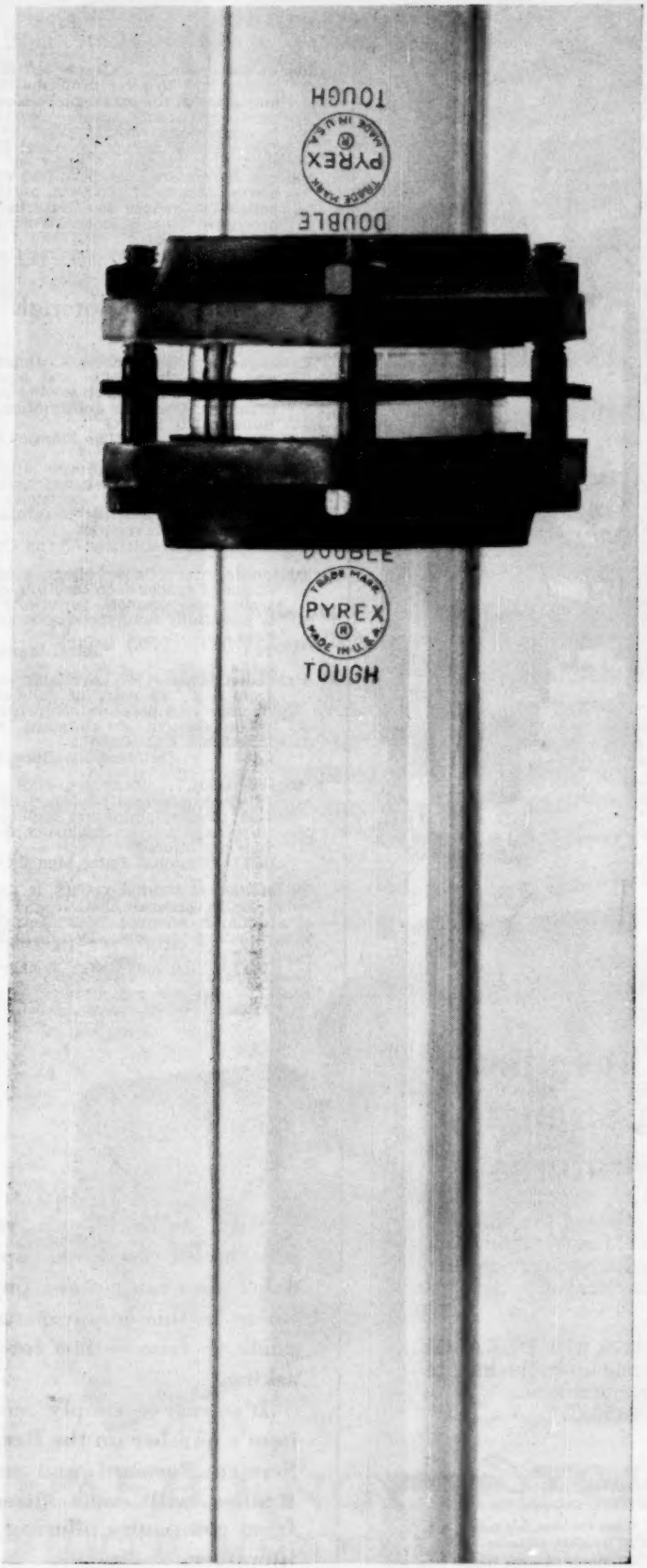
Chemical, Sulfan.....Technical brochures, "Reactions of Sulfur Trioxide" and "Sulfan" have been prepared outlining the many advantages of Sulfan and are available.
39 *Allied Chemical

Plastic.....Teflon is easily bondable to other materials and to itself with commercial adhesives. Complete Teflon service to help improve design & increase reliability.
152 *Raybestos-Manhattan, Inc.

Porcelains.....Custom made Chemical Porcelain used where acid and abrasion-resistant surfaces are needed. Description and specifications are available.
125 *Lapp Insulator Co., Inc.

Propylene Glycol.....Commercial grades are invaluable in polyster resin production. Full information on any grade and thirteen other diols and triols.
85 *Union Carbide Chemicals Co.

* From advertisement, this issue



How to run a simple test study on PYREX® pipe and corrosion

A few hours and a few dollars may be enough to end corrosion in your piping altogether.

Choose a process line where you have the worst corrosion. Put in a length or a section of PYREX pipe. Sit back and let the pipe go to work.

We are positive you'll learn two things from this study.

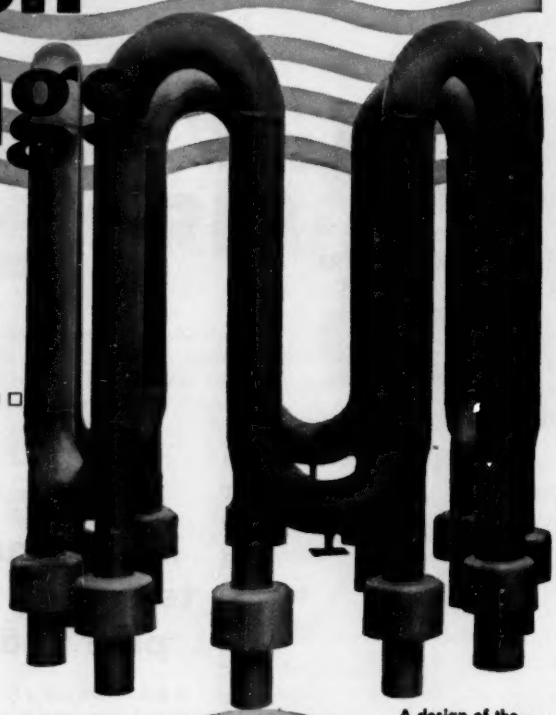
You'll find the PYREX pipe can indeed end your corrosion problems unless you're handling large quantities of hydrofluoric or glacial phosphoric acid, or hot alkalies. Any other chemical or combination of chemicals should slip through without a trace of corrosion.

You'll find that PYREX pipe installs so much more easily and so much faster than most other materials that it is actually one of the least expensive piping materials you can use.

Your local PYREX pipe distributor can show you how to attach this pipe to your present lines—fittings are available for making attachment to any type of process pipe. See our insert in Chemical Engineering Catalog. Or, if you prefer, you can write direct to us for a copy of PE-3, the PYREX Pipe Bulletin. Address: Plant Equipment Sales, 8902 Crystal Street, Corning, N. Y.

CORNING GLASS WORKS
CORNING MEANS RESEARCH IN GLASS

when things are HOT... call on Duraloy



A design of the A. F. Holden Co., Detroit, Mich.

Castings that Keep their Load-Carrying Strength at High Temperatures

This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY... our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.

ALLOY CASTING INSTITUTE ACI MEMBER

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.

CHICAGO OFFICE: 332 South Michigan Avenue

DETROIT OFFICE: 23908 Woodward Avenue, Pleasant Ridge, Mich.

LITERATURE . . .

Resins Extrusion.....Charts tell at a glance how to solve problems that may arise in the extrusion of tough, hard, rigid resins: covers variations in dimensions, prosity, etc.
170A Marbon Chemical Div.

Silicone Deformers.....work fast with a wide variety of products, prevent boil-overs, reduce fire hazards. A brochure "How Silicones Work for CPI" is available.
15 *Dow Corning Corp.

Construction Materials

Castings.....Ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. Complete information in Bulletin No. 3150 G.
170 *The Duraloy Co.

Coating.....No other process applies a hard, corrosion-resistant coating without the use of electricity as Kanigen does. Further information is available on request.
47 *General American Trans. Corp.

Diatomite.....Celite offers a wide choice of grades each carefully controlled for complete uniformity. It is essentially nonhygroscopic. Tech. data.
75 *Johns-Manville

Extension Cable.....Available with from 4 to 48 pairs of solid-conductor temperature-compensated wires. Custom & standard constructions. Cat. G100-2.
L185 *Minneapolis-Honeywell

Glass Fabrics.....Many weaves of glass fabrics engineered for liquid filtration, plastics lamination, high temp. dust collection or insulation. Samples are offered.
163 *National Filter Media Corp.

Insulation.....Unarco U200 is available in accurate, half-round sections; in nominal thicknesses & in standard pipe sizes. Details in Bulletin No. U200-1.
129 *Union Asbestos & Rubber Co.

* From advertisement, this issue

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

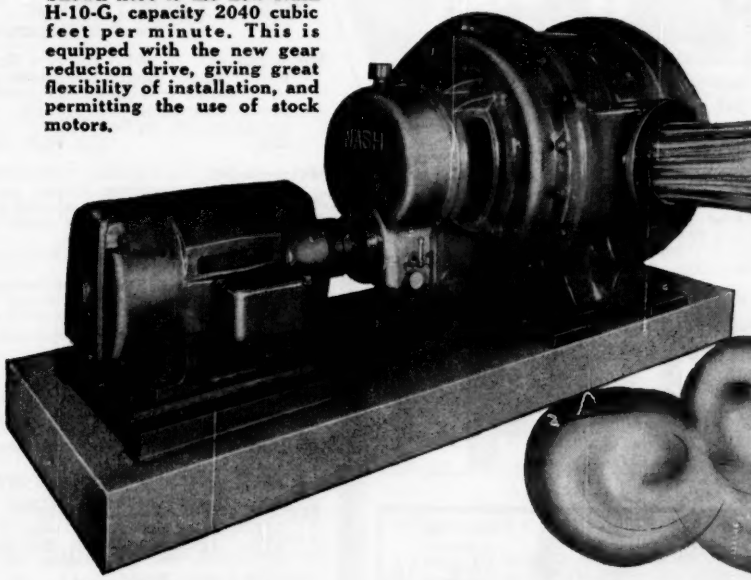
It's easy — simply circle item's number on the Reader Service Postcard and mail. Replies will come directly from companies offering the literature.

Nash Compressors Tame "Hard-to-handle" Corrosive Gases

The reasons for the success of Nash Compressors in handling "dirty" and corrosive gases are simple. First, Nash Compressors have no internal parts in wearing contact, or requiring close tolerances and internal lubrication. Second, because of the Nash operating principle, a variety of liquids can be employed as the compressant medium, protecting the interior from corrosive action. Third, the pump casing may be fabricated from a variety of special metals and alloys. That is why Nash Compressors take these rugged jobs in stride.

Nash Vacuum Pumps offer the same basic advantages when handling corrosive gases, and reliably maintain vacuums up to 29.50 inches of mercury.

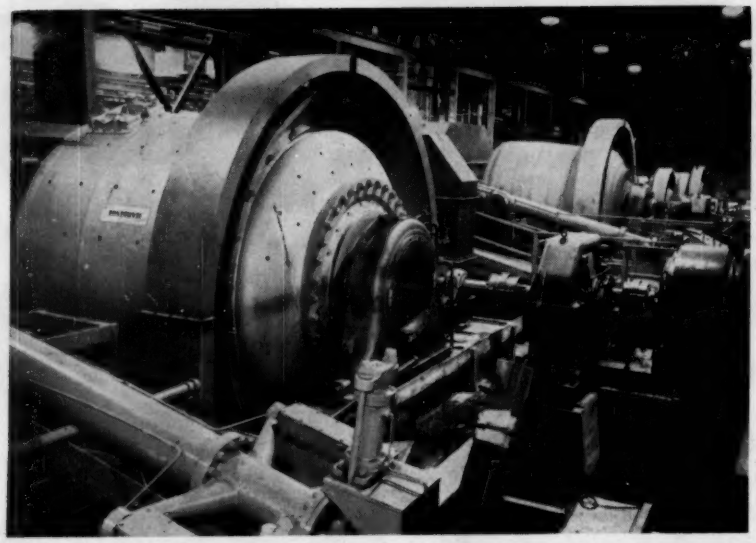
Shown here is the new Nash H-10-G, capacity 2040 cubic feet per minute. This is equipped with the new gear reduction drive, giving great flexibility of installation, and permitting the use of stock motors.



ACETONE
ACETYLENE
AMMONIA
ARGON
BUTADIENE
CARBON DIOXIDE
CARBON MONOXIDE
CHLORINE
ETHYL CHLORIDE
FLUE GAS
FURFURAL
HEXANE
HELIUM
HYDROGEN
HYDROGEN SULPHIDE
NITROGEN
OXYGEN
PHOSPHOROUS PENTOXIDE
SULPHUR GAS
VINYL ACETATE
VINYL CHLORIDE
AND MANY OTHERS

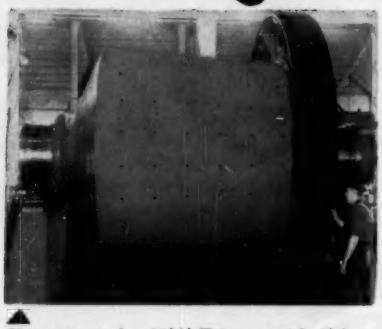
NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.



11-3-6-10 Hardinge Tricone Mills in the Grinding Department of Opemiska Copper Mines, Ltd. Two Hardinge 8' x 72" Conical Mills can be seen in the Background.

CORRECT BALL SEGREGATION in the HardingeTRICONE MILLS

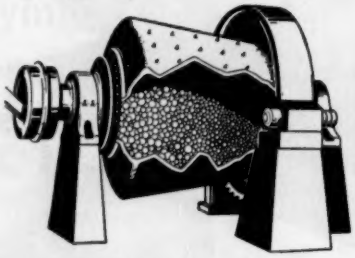


Shop view of a 10½' Tricone with 9' long tapered shell.

Highest grinding efficiency and lowest ball and lining wear are common to mills with a correctly segregated ball charge. The Hardinge Tricone Mill is the only mill providing these essentials to low cost operation without the use of special linings or internal devices, which are subject to wear and are effective through only a part of their wearing life.

The Tricone also occupies less floor space for its grinding volume than any other ball mill built.

Every ball in the Hardinge Tricone Mill "minds its own business!"



Complete specifications upon request. Bulletin AH-414-11

HARDINGE
COMPANY, INCORPORATED
Main Office and Works • 240 Arch St., York, Pa.
"Hardinge Equipment—Built Better to Last Longer."

NEW YORK
TORONTO
CHICAGO
HIBBING
SALT LAKE CITY
SAN FRANCISCO
HOUSTON
LAKELAND
BIRMINGHAM

LITERATURE . . .

Packing.....Enjoy premium benefits without premium price with Garlock 5875 Teflon packing. Complete information on this useful packing is available in Catalog AD-185.
16 *Garlock, Inc.

Platinum Metals.....in all shapes and forms...sheet, strip, foil, wire, tubing, gauze, salts and chemicals. Clads & composites also available in many forms. Bulletin P-6.
61 *J Bishop & Co.

Refractory.....Korundal XD is very dense, strong & has good resistance to thermal shock. Its high hot strength & improved properties will solve many problems. Info.
57 *Harbison-Walker Refractories

Refractory, Silicon Carbide.....Crystolon "63" has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. Information.
63 *Norton Co., Refractories Div.

Steel Tubing.....Regardless of the shape or size, when you specify domestically-produced steel tubing, you are assuring uniformity. Useful information available.
173 *Welded Steel Tube Inst., Inc.

Electrical & Mechanical

Couplings.....are available in Brass, Malleable, Stainless, Aluminum, Monel, or other materials for corrosion resistance under any conditions. Illustrated Cat. C-11.
45 *Ever-Tite Coupling Co., Inc.

Couplings.....Basic type F Steelflex coupling can be used horizontally or vertically, without modification or special parts. Information in Bul. 4100.
53a *The Falk Corporation

Motor Mount.....With the new Equi-Poised Motor Mount the motor can be mounted in almost any position around perimeter of reducer. Dimensions, etc. in Bul. 7100.
53d *The Falk Corp.

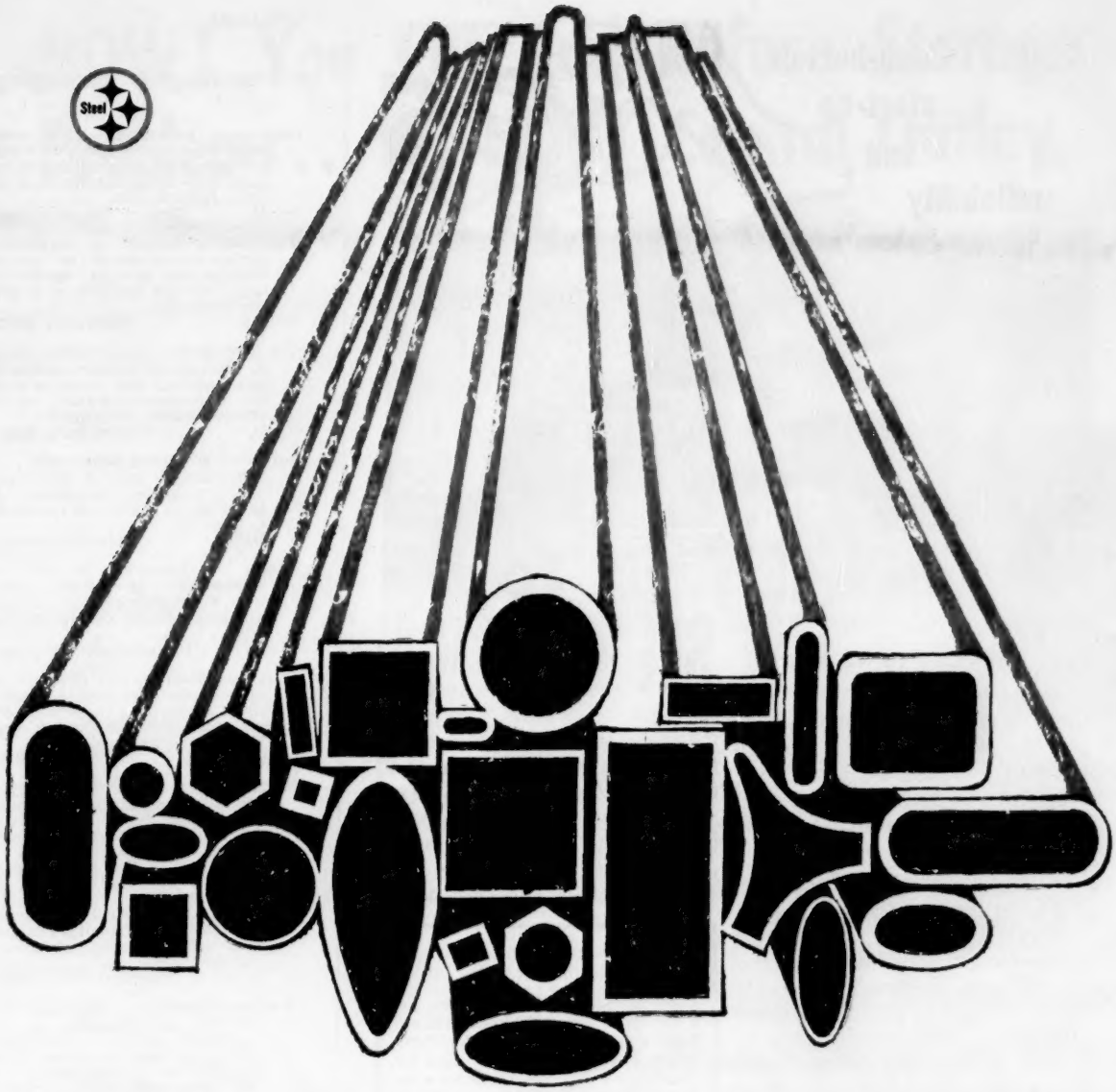
Motoreducers.....All-Steel Motoreducers with horsepower range: to 75 hp...standard output speeds: 780 rpm (high) to 1.2 rpm (low) are covered in Bulletin 3100.
53c *The Falk Corp.

Rotating Seal.....There is a standard type and size Rotary Union for heating & cooling any revolving roll or drum. Pipe sizes ¼" through 5". Bulletin 700.
L137 *Perfecting Service Co.

Safety Head.....Used with or without a relief valve, the safety head is your way of being absolutely certain you have over-pressure protection.
145 *Black, Sivalls & Bryson

Speed Control.....Ampli-Speed has nearly stepless speed change & gives speed regulation within ± 2%. Illustrated publication No. 243 tells how it works.
141 *Electric Machinery Mfg. Co.

Speed Reducers.....Parallel Shaft up to 3500 hp. Right angle and concentric shaft designs are also available. Complete details on all models in Bulletin 1100.
53b *The Falk Corp.



DESIGN WITH SAFETY...IN ALL SHAPES AND SIZES!

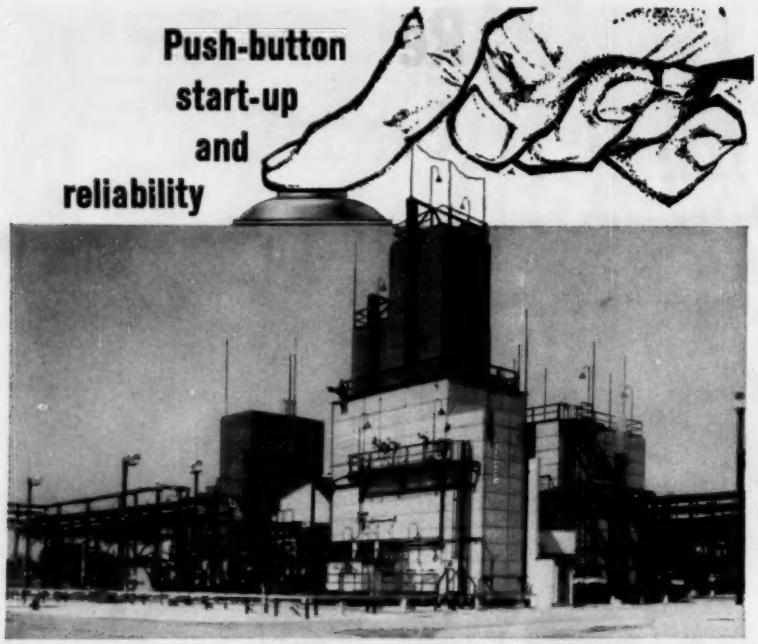
Armco Steel Corp.§
The Babcock & Wilcox Co., Tubular Products Div.§‡
The Carpenter Steel Co., Alloy Tube Div.‡
Clayton Mark & Co.§
Jones & Laughlin Steel Corp., Electricweld Tube Div.§
National Tube Div., United States Steel Corp.§
Ohio Seamless Tube Div., Copperweld Steel Co.§
Republic Steel Corp., Steel and Tubes Div.§‡
Revere Copper & Brass Inc., Rome Mfg. Co. Div.§‡
Sawhill Tubular Products, Inc.§‡
Southeastern Metals Co.§
The Standard Tube Co.§‡
Standard Tube and T. I. Ltd., (Canada)§
Superior Tube Co.‡
Trent Tube Co., Subs. Crucible Steel Co. of America‡
Union Steel Corp.‡
Van Huffel Tube Corp.§
Wall Tube & Metal Products Co.‡

‡PRODUCES STAINLESS STEEL TUBE
§PRODUCES CARBON STEEL TUBE

Regardless of the shape or size, when you specify domestically-produced welded steel tubing, you are assuring uniformity. Wall thicknesses are uniform, concentricity exact. In a rotating part, the result is a better, safer, vibration-free operation. In other applications, the welded steel tube gives you the same design strength as bar stock, with less weight.

The quality producers at left are prepared to help you design with tubing in all weldable grades of carbon, stainless steel and other alloys. You can get useful information from any of them or by writing Dept. CE-1, Welded Steel Tube Institute, Inc., Hanna Building, Cleveland 15, Ohio. It will pay both you and your customers — in uniformity, safety, and savings in weight.

WELDED STEEL TUBE INSTITUTE, INC.



FULL CAPACITY IN 48 HOURS.

Push-button start-up — the ultimate aim of every plant engineer and designer — takes a lot of experience, particularly in the low-temperature separation field. Air Liquide has that experience: more than fifty years of designing and building all types of low-temperature separation plants.

Here is an example: a large high-purity oxygen plant (*above*) located in Texas. Designed and built by Air Liquide to produce close to 400T/D of 98% oxygen plus a stream of high-purity nitrogen, this plant was in full production *only 48 hours after completion of pressure testing.* Furthermore, extreme flexibility of operation was proved during acceptance tests with completely satisfactory operation over all its designed range, with oxygen purity up to 99.6% and nitrogen purity of less than 100 ppm.

Fabricated of stainless steel and aluminum, equipment and piping were engineered so that a field team could erect the plant with maximum efficiency, yet without modifying the basic principles of low-temperature design.

Air Liquide cryotechniques provide a complete low-temperature gas separation service to industry: process and project engineering of complete plants and custom-designed equipment, technical consultation for special requirements, manufacturing of plants and equipment, plant erection and start-up supervision.

Plants designed and built by Air Liquide include:

• Air Separation — oxygen, nitrogen, etc. • Tonnage Oxygen and Nitrogen (gas and liquid) • Rare Gases Recovery • CO_2 Purification • Methane Purification • Natural Gas Liquefaction • Hydrogen Liquefaction • Hydrogen Recovery for Ammonia Synthesis Gas • Coke-Oven Gas Separation • Helium Recovery • Refinery Gas Separation • Pure CO Production • Heavy Water for Atomic Reactors.

For complete information write or call

AMERICAN
AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION
OLDEST IN EXPERIENCE · NEWEST IN DESIGN

Chrysler Building, 405 Lexington Ave., New York 17, N.Y. Telephone: YUkon 6-6544

In Canada:
L'Air Liquide, 1210 Sherbrooke St. W., Montreal, Quebec. Telephone: Victor 2-5431.

✱ **ALL AIR LIQUIDE LOW-TEMPERATURE PLANTS ARE DESIGNED AND BUILT IN NORTH AMERICA FROM NORTH AMERICAN MATERIALS — TO NORTH AMERICAN STANDARDS**

LITERATURE . . .

Handling & Packaging

Conveyors, Airstream.....A new 32 page brochure presents detailed information on how these conveyors solve bulk materials handling problems. Bulletin 530.
41 *Dracco, Div. of Fuller Co.

Dumpmaster Hauler.....Brochure describes the service of the Dempster-Dumpmaster equipped hauler in detail. Provides containers & service for small fee.
175 *Dempster Brothers

Gas Transports.....Exereme mobility & economical storage makes Taylor-Wharton gas transports ideal for bulk transportation of compressed gases. Information.
51 *Harrisburg Steel Co.

Industrial Weighing Equipment.....Information on the full line of industrial weighing equipment from 1/100 oz. to 100 ton is available on request.
BL195 *Detector Scales, Inc.

Loader.....Loads can be palletized or stacked in any pattern, also put into warehouse storage. Literature and engineering details are available.
T178 *Power-Curve Conveyor Co.

Materials Handling.....Graphic, push-button, one-man control panel handles unloading, conveying & reclaiming. Information on systems for specific problems.
177 *Fuller Co.

Payloader.....Model H-25 Payloader offers extraordinary protection such as cartridge-type oil filters. A booklet "Industrial Materials Handling from A to Z" is offered.
17 *The Frank G. Hough Co.

Scales, Industrial.....Hopper or tank scales are designed specifically for the Chemical Industry. Can be custom-built to your specifications. Information.
R136 *Cardinal Scale Mfg. Co.

Tractor Shovels.....Michigan Tractor Shovels are available in a wide variety of models for excellent performance and economy. Further information is available.
28 *Clark Equipment Co.

Truck Scale.....Printweigh "400" automatically prints weight records in triplicate on certified weight certificates. Full details are contained in Bul. 2417.
162 *Toledo Scale Co.

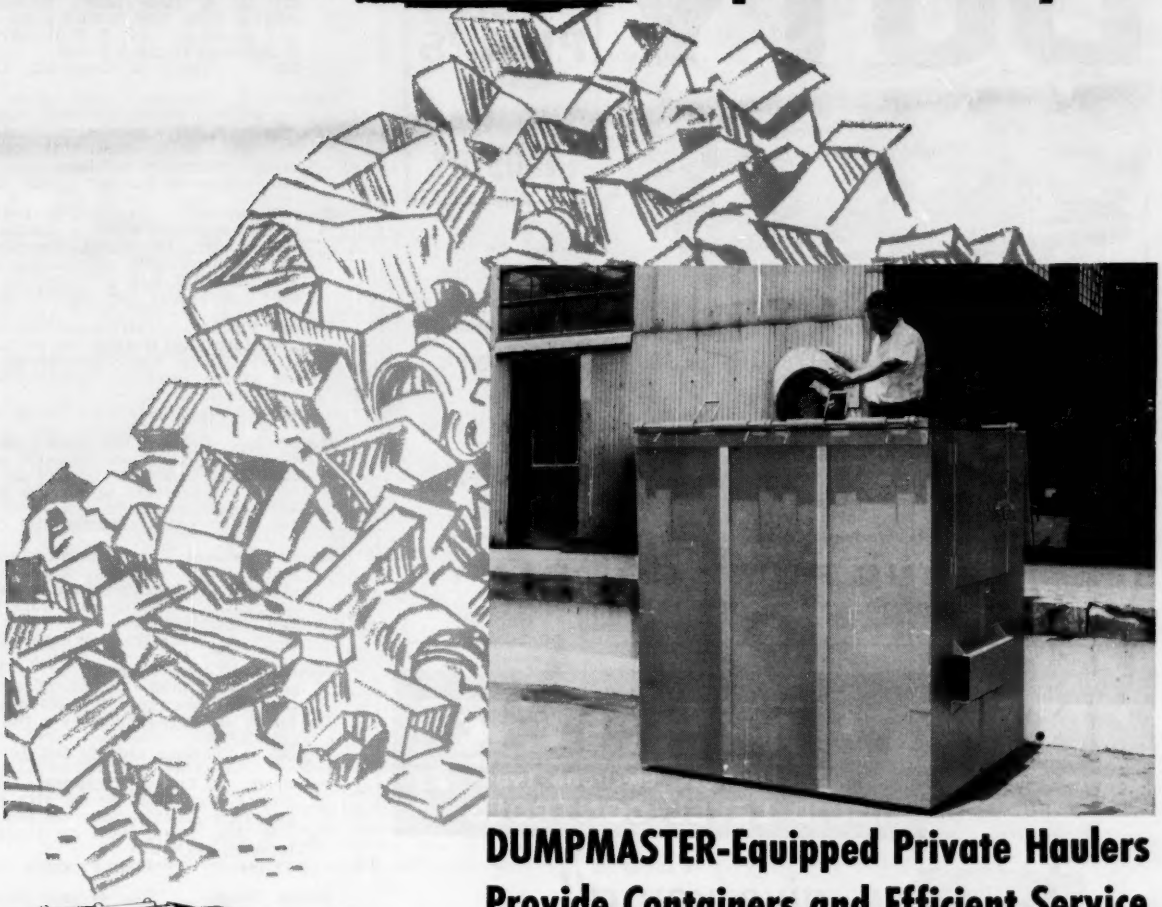
Heating & Cooling

Air Conditioner.....Rotaspray Weathermaker System eliminates many components, offers better temperature and humidity control, superior efficiency & savings. Information.
20 *Carrier Air Conditioning Co.

Air Cooling.....New portable air cooling unit for industrial uses eliminates exposure to hazards created by contaminated air conditions. Engineered for any requirement.
TL195 *Antelline Constructors

*From advertisement, this issue

NOW! You Can End Refuse Storage Problems...WITHOUT Capital Outlay



DUMPMASTER-Equipped Private Haulers Provide Containers and Efficient Service

If you're plagued with trash piles, scattered refuse, fire hazards, and hit-or-miss collection, there's a good chance you can do something about it . . . WITHOUT CAPITAL OUTLAY!

In most major cities DEMPSTER-DUMPMASTER-equipped private haulers will put clean, big-capacity storage containers at convenient locations in your plant . . . empty them mechanically on schedule, or on a call-in basis . . . all for a reasonable monthly fee.

When you containerize your refuse, plant housekeeping becomes easy, employee morale goes up.

Write today for the name of your nearest private hauler. We'll also send literature describing his service.

IN ALL LEADING CITIES FROM COAST TO COAST

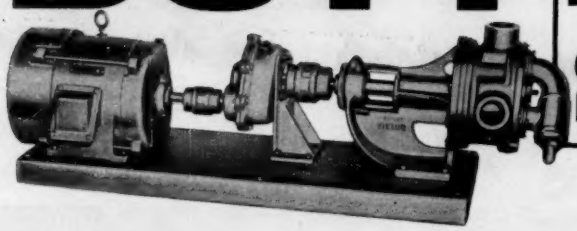
DEMPSTER DUMPMASTER®
Equipped Private Haulers

Write Today for
Free Brochure and Name of Nearest Private Hauler
DEMPSTER BROTHERS
Inc.
Dept. CE-2 KNOXVILLE 17, TENNESSEE

WITH VIKING

HEAVY DUTY

288 PUMPS FOR THE CHEMICAL INDUSTRY



YOU HAVE: 5 Gear reductions, 4 pump sizes, 20 capacities ranging from 17 to 164 G.P.M. ***You also have:***

- Pumps built for 200 PSI handling lubricating liquids, 100 PSI non-lubricating liquids.
- Pumps built for delivering THIN or THICK liquids up to 75,000 S.S.U.
- Positive, fast self-priming.
- Smooth, even discharge.
- Exceptionally quiet operation.
- Simplicity in servicing. Each component (pump, gearing and motor) can be removed separately.

For complete information, write for catalog CC, P. 27-28

50 YEARS

VIKING PUMP COMPANY

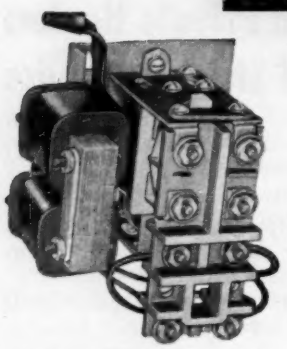
Cedar Falls, Iowa, U.S.A. In Canada, It's "Roto-King" Pumps

See Our Unit In Chemical Engineering Catalog

WARRICK

Floatless, Electrode Type

LIQUID LEVEL CONTROLS



Two pole control shown above

Write for 32-page Catalog which gives complete specifications

Special controls to custom requirements

give you all these advantages!

No moving parts in the liquid • Easy to install • No adjustments necessary • Unaffected by acids or caustics • Unaffected by pressure or temperature • Standard 2&3 pole unit listed by U/L

YOU CAN USE OUR CONTROLS FOR:

- Single & Multiple pumps
- Motor & solenoid valves
- High & low cutoffs, & alarms
- Condensate contamination
- Storage tanks
- Volumetric Metering
- Waste sumps

Dept. 12

CHARLES F. **WARRICK** COMPANY

1961 W. Eleven-Mile Road
Berkley, Michigan
Telephone JOrdan 4-6667

LITERATURE . . .

Boilers, Water Tube Little space is required because of their compact design. Literature is offered for further details along with Package Unit Bulletin PSG-3.
86 *Henry Vogt Machine Co.

Dryers, Desiccant.....Are designed to dry air & gases under pressure ranging from 1000 to 6000 psig) to dew points of —160 F. Full details in Bulletins D-108 & D-109.
161 *The C. M. Kemp Mfg. Co.

Furnace.....Successful applications of the Skinner Furnace include: Oxidizing Roast, Reduction Roast, Chloridinz Roast, and Drying. Many other applications possible.
143 *Mine & Smelter Supply Co.

Heat Transfer.....Platecoil is available in standard styles or specially formed and fabricated. Complete engineering data & assistance available. Bul. P61.
127 *Tranter Mfg. Inc. Platecoil Div.

Heater, Fired.....Petrochem Vertical and Horizontal Heaters can be built in every size and type for every use in any location. Complete details are available.
115 *Yuba Consolidated Industries

Heaters.....Catalog 956 covers Grid Unit Heaters, Blast Heaters and Radiators. Designed for operation on steam pressure up to 250 PSI 450 degree temperature.
168 *D. J. Murray Mfg. Co.

Heaters, Radiant.....Chromalox heaters are fast, uniform, economical and safe. Adjustable from 0 to 100% of heating capacity by fingertip control. Bulletin G-2.
26 *Edwin L. Wiegand Co.

Miniature Thermocouples ..... are avail in a wide variety of sizes, standard thermocouple materials, adapt to many applications. Bulletin 1256-4.
155 *Thermo Electric Co., Inc.

Panelcoil.....Latest Technical Data Sheets Nos. 15-60 Series give engineering specifications on Panelcoil. Also prices sent on request. Bulletin 259.
TR194 *Dean Products, Inc.

Steam Traps.....The 44-page steam trap book discusses trap selection, installation and maintenance. Covers its excellent air handling characteristics.
23 *Armstrong Machine Works

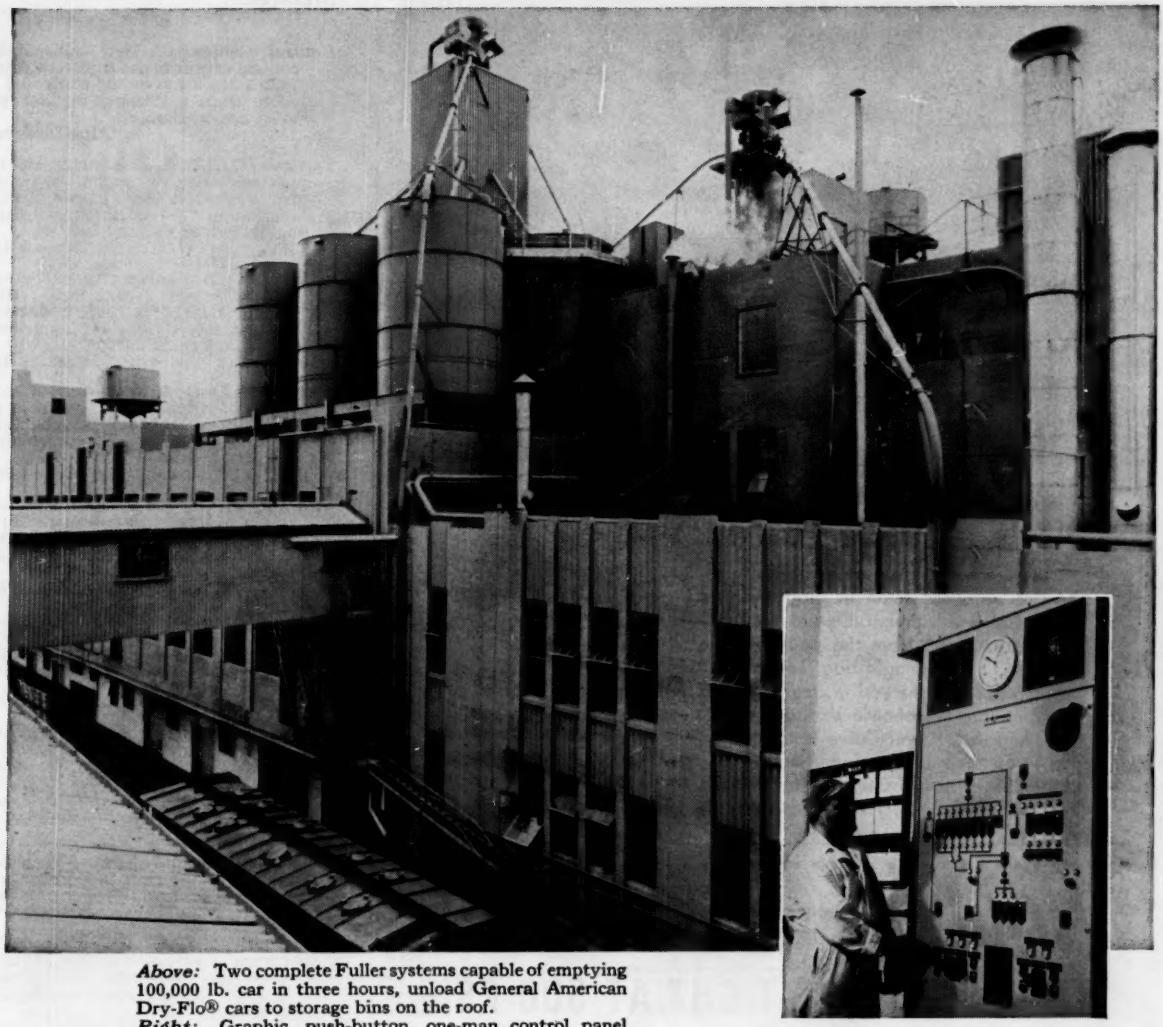
Steam Traps.....Thermostatic steam traps operate on a true balanced vapor-pressure principle, they discharge air, condensates & other non-condensables. Cat. 400.
157 *W. H. Nicholson & Co.

Instruments & Controls

Air Scrubber.....New line of miniature, high pressure instrument air scrubber and dehydrators, suitable for use with dry or wet type desiccants described in bulletin No. 7.
176A Robertson Mfg. Corp.

Comparators.....Handbook "Modern pH and Chlorine Control" gives theory and application of pH control. It also illustrates and describes full Taylor line.
L183 *W. A. Taylor & Co.

*From advertisement, this issue



Above: Two complete Fuller systems capable of emptying 100,000 lb. car in three hours, unload General American Dry-Flo® cars to storage bins on the roof.
Right: Graphic, push-button, one-man control panel handles unloading, conveying and reclaiming.

NO PLACE TO GROW BUT UP

. . . so Burgermeister put 12 new storage bins on the Brewhouse roof

Putting a head on beer is one thing, but putting a head on the Brewhouse roof might seem an insurmountable obstacle. This growing San Francisco brewery was up against it for storage space. With no further room for lateral expansion, the only place to grow was up—but how? Could additional bins be loaded at such a height?

Fuller engineers were able to provide the answer. Airveyor® Pneumatic Conveying Systems don't balk at height. So twelve additional bins were mounted on top of existing equipment, and two separate Airveyor systems were installed. They even incorporate components from an existing Airveyor system which had been installed in 1947.

Now, with ample storage space, grits are unloaded from covered hopper cars to bins in just over three hours per 100,000-lb. car. The same quantity of malt travels the route in a little over two hours. And reclaiming and blending are handled at an equally high rate—all controlled by one man at a Fuller graphic control panel. Burgermeister has greater production with greater economy — as breweries must do to keep ahead today.

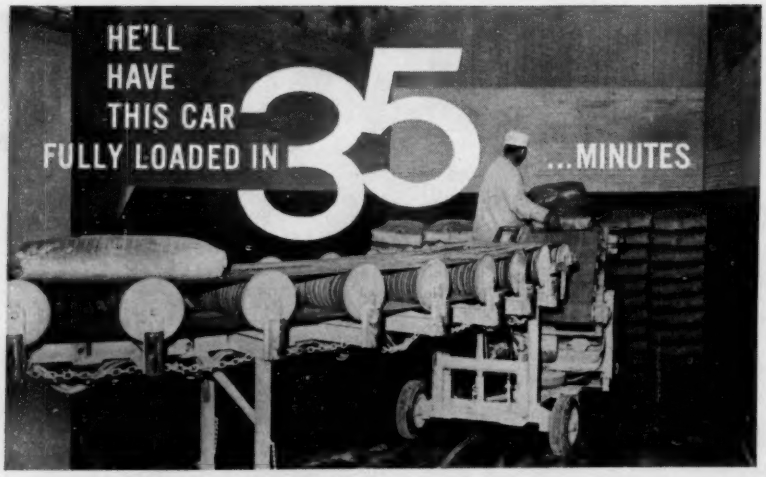
The success of Fuller in handling problems like those at Burgermeister is confirmed by repeat orders from customers everywhere. Breweries nation-wide look to Fuller to study their needs for expansion, higher production and for new brewery installations. Why not find out for yourself why they do it—and what Fuller can do for you? 2625 A-29 2

"See Chemical Engineering Catalog for details and specifications".

FULLER COMPANY GENERAL TRADE MARK

FULLER COMPANY
134 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
. . . pioneers in harnessing AIR



...without help, using a
POWER-CURVE Loader

Bag loading costs of eight cents a ton are not uncommon in plants using Power-Curve equipment. One man loads and stacks direct from the packer with no need to lift a single bag. Loads can be palletized or stacked in any pattern, also put into warehouse storage.

There are Power-Curve installations near you. Let us show you how your plant can benefit from a custom engineered Power-Curve loading operation.

Literature and engineering details sent on request.

POWER-CURVE
CONVEYOR COMPANY
2185 SOUTH JASON ST., DENVER 23, COLORADO

NOW! A BUTTERFLY VALVE THAT'S BUBBLE-TIGHT AT 500 PSI!

- Capacity approximately 1½ times greater than globe valves.
- Handles temperatures from −60°F. to +450°F.
- For 60° throttling or 90° on and off.
- Equal percentage flow for good control.
- Closing speeds as fast as ⅓ second.
- Low in cost, weight and maintenance.

Available in special materials or construction and as manual or with various types of operators.

FISHER-CONTINENTAL
RUBBER-SEATED
VALVES

For complete details about Fisher-Continental Butterfly Valves send for free literature.

FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario / Rochester, England
Direct inquiries to: CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Penna.

FISHER Controls

LITERATURE . . .

Control Center.....New SpaceMaker control center is the first completely new 2- to 5-kv. motor controller in more than a decade. Further details are available.
133 *Allis-Chalmers

Controls.....The Massometer is calibrated with any maximum output between 40 & 200 lbs. per minute. Maximum volumetric capacity is 6 cubic ft. per minute. Details.
153 *Wallace & Tiernan Inc.

Data-Trak.....follows pencil drawn graphs anyone can prepare. High degree of accuracy and reliability. Potentiometer output is proportional to drawn curve.
144 *R I Research Inc.

Electronic Control Station.....Consotrol stations are available for cascade, ratio and auto-selector systems. Additional information contained in Bul. 21-10.
29 *The Foxboro Co.

Gas Chromatograph.....offers rapid response, efficient analysis performance, reliability of operation and minimum maintenance requirements. Data File 14-6-07.
24 *Beckman Instruments, Inc.

Liquid Level Control.....is available for controlling level changes from ⅛" to 150 ft. Multi-stage switching when desired. Information on Magnetrol on request.
B180 *Magnetrol, Inc.

Liquid Level Controls.....Floatless Electrode type are unaffected by acids or caustics. Standard 2 & 3 pole units listed by U/L. Complete specifications in 32-pg. Catalog.
B176 *Charles F. Warrick Co.

Pressure Indicating Switch.....The 257 differential pressure indicating switch is accurate, responsive, easy to read & infinitely dependable.
142 *Barton Instrument Corp.

Recorder.....Continuous Freeness Recorder offers trouble-free performance and negligible maintenance. Further information is available on request.
84 *Bailey Meter Company

Pipes, Fittings, Valves

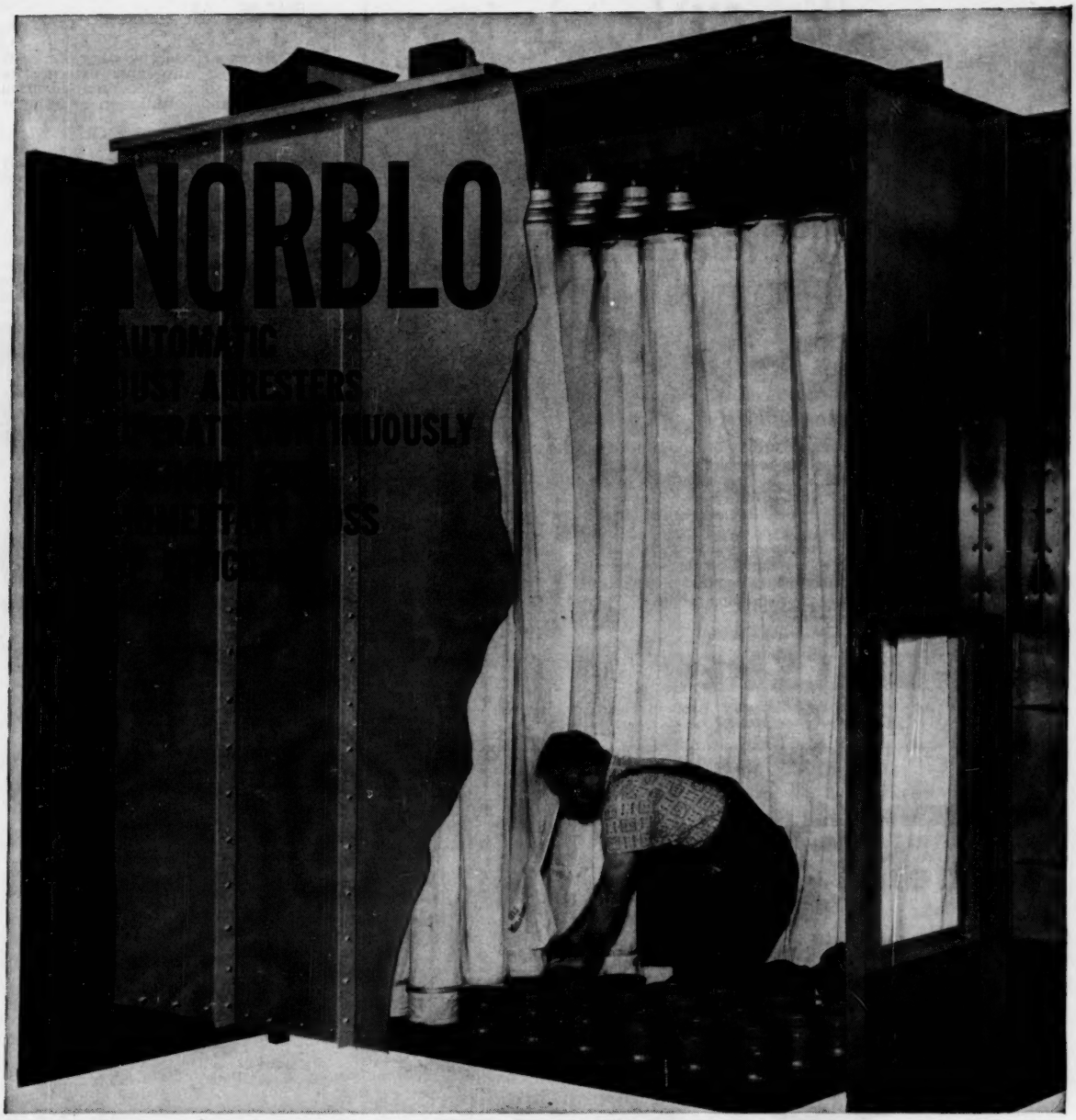
Copper Tube.....Anaconda copper or copper-alloy tube provides high corrosion resistance internally to cooling waters, steam and refrigerants.
146 *The American Brass Co.

Fittings.....Forged stainless and carbon steel fittings feature hardness differential between seats to avoid galling. Catalog 16-59 gives complete information.
150 *Camco Fittings, Inc.

Pipe, PVC.....Koroseal PVC pipe is lightweight, resists acids, corrosion, aging, weather & abrasion. It will not support combustion, is an excellent insulator. Details.
1 *B. F. Goodrich

Pipe, PVC.....available in sizes from ½ inch to 12 inches in diameter & schedules A, 40, 80, 80, & 120. Easy to fabricate & join, has excellent impact resistance. Bul. 24.
55 *U. S. Steel, National Tube Div.

*From advertisement, this issue



Periodic cleaning, repair or replacement of bags, and minor maintenance can be accomplished while the collector remains in operation. One compartment, as shown above, can be isolated in the Norblo design, with all mechanical parts outside the gas stream. Continuous cyclic shaking, by compartment, allows operation without interruption. ■ This is why in modern plant operations you'll find an increasing preference for Norblo Automatic Bag Arresters. Where efficient production requires continuous operation more and more industries specify Norblo Dust Arresters. Over 80% of the cement industry relies on Norblo equipment for drying, grinding and finishing operations. ■ Buell-Norblo equipment can play an essential part in your process. Write for complete information on any type of dust collection problem. Buell Engineering Company, Inc., Dept. 12B, 123 William Street, New York 38, New York. Northern Blower Division, 6411 Barberton Avenue, Cleveland, Ohio. Electric Precipitators · Cyclones · Bag Collectors · Combination Systems · Fans · Classifiers.

buell Norblo

DIAL THIS PUMP FOR THICK OR THIN

Vari-Flo changes capacity instantly

If you're moving a variety of liquids—or one liquid at changing temperatures—there's no need to use several pumps. One Blackmer Vari-Flo can solve your problem, save you time and money. With Vari-Flo, you just dial a low capacity for thick liquids, then gradually increase the rate as the liquid gets thinner. Even reverse the flow without changing pump speed or direction! Vari-Flo does all this with an ordinary, standard-speed motor. See how it works to solve your pumping problems. Write for Bulletin 600.

"liquid materials handling"® equipment

BLACKMER / *vari-flo pumps*

BLACKMER PUMP COMPANY, GRAND RAPIDS 9, MICHIGAN

Find your Blackmer Man under "Pumps" in the Yellow Pages

permanent magnetic force...

A sleeve, raised and lowered within a nonmagnetic tube, attracts or releases an Alnico magnet attached to the mercury (or dry contact) switch. Basically, this is Magnetrol.

The operating principle behind MAGNETROL LIQUID LEVEL CONTROL

Because its operating principle, based on the proper use of a permanent magnet, guarantees a perpetual guardianship over your critical liquid levels, the Magnetrol liquid level control unobtrusively takes the most important place in any system or process where it is necessary to keep a liquid at a constant level. Principle and action are so simple that failure is virtually impossible. Magnetrol is versatile, too—will handle almost ANY liquid, at ANY temperature, at ANY pressure, with the same precision and dependability. No mechanical or electrical linkages to stick, bind, ride out of line or wear out. Available for controlling level changes from ⅛" to 150 ft. Multi-stage switching when desired. Write to

MAGNETROL, Inc., 5324 Belmont Road, Downers Grove, Ill.

LITERATURE . . .

Pipe, Pyrex.....is rugged, chemically inert & it withstands extremes of thermal shock. Facts on application design, and installation in Bulletin PE-3.
169 *Corning Glass Works

Tubing.....Excelon tubing nationally distributed for industrial and laboratory uses and whenever flexibility, clarity and chemical inertness is required.
BR194 *Thermoplastic Processes, Inc.

Tubing.....a complete line of integrally-finned tubing. Services of Technical Representatives are available to the heat transfer industry at large.
73 *Wolverine Tube Div., Calumet & Hecla

Valve.....available in ¼" through 6", 150 & 300 psi, straightway & 3 way. Alloys include carbon steel, 316SS, Durimet-30, Monel, Nickel, Chlorimet-2 & Chlorimet-3. Bul. V/14.
121 *The Duriron Co., Inc.

Valves.....Corrosion-Resistant valves are available in a wide selection of materials, to handle practically every known corrosive media. Details on request.
65 *The Wm. Powell Co.

Valves.....Ram type drain valves are designed so that in the closed position the piston or ram extends up into the tank. In open position full low is assured. Catalog.
L136 *Strahman Valves, Inc.

Valve, Ball.....R-P & C BL300 for dependable, trouble-free operation in water, oil & gas service. Complete product information and specifications in Folder DH-38.
117 *American Ch. & Cab. Co.

Valves, Ball.....Fig. 700-T has screw ends, Bronze body, Teflon seats & seals. Fg. 700-B has Buna-N seats & seals, bronze body and screw ends. Details.
34 *The Lunkenheimer Comany

Valves, Butterfly.....that's bubble-tight at 500 psi. Handles temperatures from 60 F. to + 450 F. For 60 degree throttling or 90 degree on & off. Literature.
B178 *Fisher Governor Co.

Valves, Control.....A Nodular Cast Iron valve is effective in temperature ranges of —20 F. to +650 F. and pressures up to 1,000 psi. Technical Paper TM-5 offered.
19 *Fisher Governor Co.

Valves, Control.....A copy of an informal booklet called "25 Ways To Be Right"...in selecting control valve is now available on request.
6-7 *Minneapolis Honeywell

Valves, Plug.....Complete details on Rockwell-Nordstrom complete line of lubricated plug valves, lubricants and accessories are available on request.
27 *Rockwell Mfg. Co.

Valves, Solenoid.....Conduit type and grommet type. Port sizes ⅛" and ¼ NPT. Ten orfice sizes: 3/64" through ⅛". Pressures to 540 psi. New bulletin.
TL197 *Marsh Instrument Co.

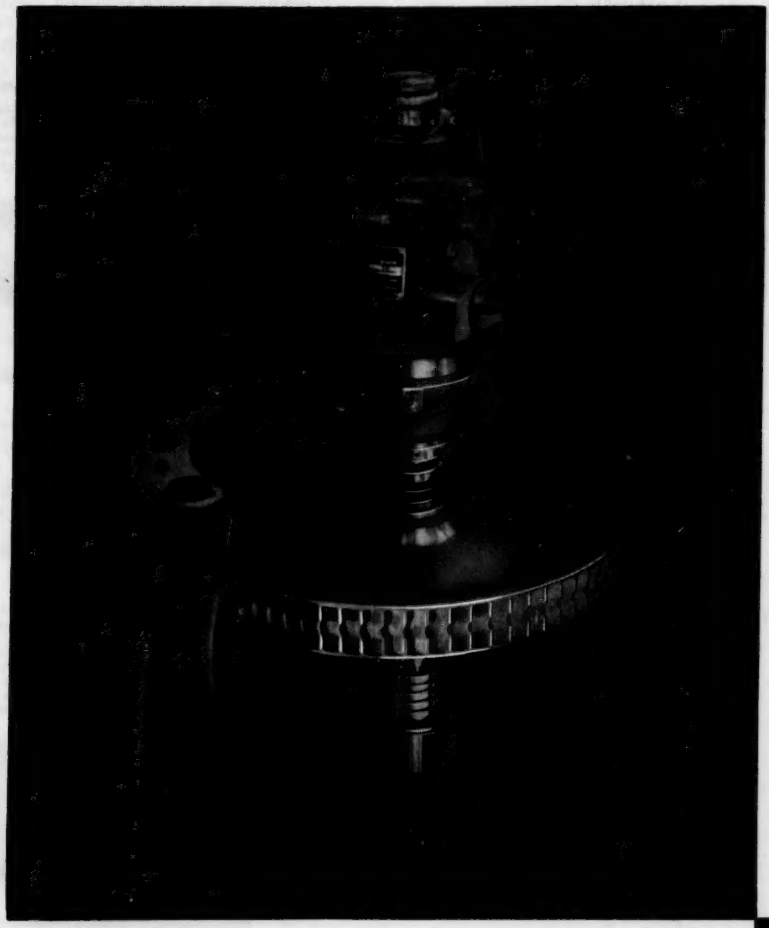
Valves, Solenoid.....Complete information on all models available. Also a 16-page brochure which lists over 500 corrosive media...coded for correct valve selection.
L182 *Valcor Engineering Corp.

* From advertisement, this issue

Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages



When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

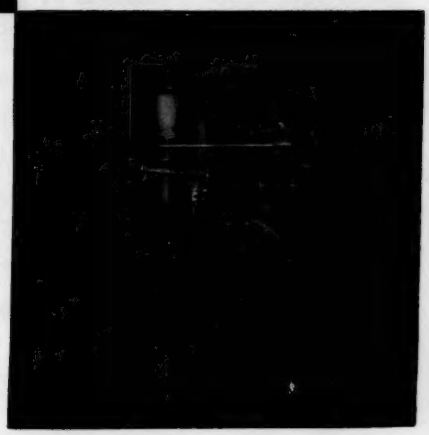
But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



TT-1210

Select from over 3,500 different SOLENOID VALVES from VALCOR

Series SV-54 (3 way-4 way) general purpose solenoid valves for air, oil and water. Rugged construction, yet inexpensive. Multi-million cycle life. Pressure ratings up to 150 psi. Nylon seat outlasts steel. Infinite varieties available... lists as low as $10.75.

Series SV-61 (2 way) Nylon body valve is ideal for general purpose and OEM installations where millions of operating cycles are vital. Nylon seat and port threads outlast steel, yet cost less. Non-corrosive, shock-resistant, proof-pressure.

Series SV-5100 Specifically designed to handle the most corrosive media in industry. Manufactured in Teflon, PVC and Nylon varieties. Diaphragm construction prevents media contact with any metal. Available in direct-acting or piloted models.

FREE... new 16 page brochure — lists over 500 corrosive media — coded for correct valve selection.

For complete information on these or other models, write or call:

VALCOR VALCOR SOLENOID VALVES **ENGINEERING CORP.**

5372 Carnegie Ave., Kenilworth, New Jersey
CHestnut 5-1665

LITERATURE . . .

Fume Washer.....Cyclonaire absorbs noxious and corrosive fumes, removes irritating & abrasive dusts and suppresses oil & acid mists. Technical data in Bul. FW-10R.
32 *U. S. Stoneware

Gas and Liquid Drying.....The Molecu-Dryer for your many new drying needs. A comprehensive picture of the Molecu-Dryer is contained in Bulletin 5703.
R183 *C. I. Hayes, Inc.

Glass Lined Process Equipment..... Glascote 778 glass is now standard on all Glascote equipment. A resistance rule has been prepared & is available on request.
8-9 *Glascote Products, Inc.

Hydraulic Systems.....Packaged hydraulic systems assure faster, more reliable process control. Bulletin 15802, "Packaged Hydraulic Systems for Process Control" is offered.
123 *Vickers Inc.

Jaw Crusher.....with cast steel frame, anti-friction side bearings and bumper bearings are covered in detail in Bulletin C12-B12. Sizes from 2¼" x 3½" to 36" x 48".
158d *Denver Equipment Co.

Mills.....Complete information. on "Jet-O-Mizer" Mills, "Jet-O-Clone" Dust Collectors, and testing and custom grinding services is now available on request.
140 *Fluid Energy Processing & Equip.

Mills.....Tricone Mills feature correct ball segregation. Also occupies very little floor space for its grinding volume. Complete specifications in Bul. AH-414-11.
172 *Hardinge Co.

Mills, Ball & Rod.....in sizes 10' x 20'. All steel construction for wet or dry grinding systems. Additional information contained in Bul. B2-B20.
158c *Denver Equipment Co.

Mills, Roller.....with exclusive gearless & spur gear drives. Quality fine grinding...20 mesh to 400 mesh... micron sizes on some materials. Catalog.
31 *Williams Patent Crusher

Mills, Stainless Steel.....Morehouse mills offer greater volume, higher quality and lower power and maintenance costs. Further information is available on request.
R195 *Morehouse-Cowles, Inc.

Mills, Vibrating.....outproduct tumbling mills as much as 30 times per unit volume. The grinding charge vibrates at high speed. Complete details are available.
135 *Allis-Chalmers

Mixers.....New Shear-Flow continuous mixers cut processing cost, eliminate costly equipment and offer versatile adaptability. Further information in Bulletin RL-200.
154 *Gabb Special Products, Inc.

Process Equipment.....Complete details on CB & I-built evaporators, crystallizers and filters is available on request. Feature continuous operation, even during cleaning.
199 *Chicago Bridge & Iron Co.

Process Equipment.....Catalog "A" discusses pressing, drying and cooling equipment and will give help in solving your particular problem.
BL197
*Davenport Machine & Foundry Co.

*From advertisement, this issue

Highly Intimate Blends in 1 to 2 Minutes

Blends while discharging; No segregation or flotation

Sturtevant Rotary Blenders start 4-way blending while charging, continue it during discharge, thus producing highly intimate, even blends of dry and semi-dry materials – within 3 to 5 minutes of start of charging.

Six *complete* blending cycles per hour are common. And Sturtevant's special action produces no particle reduction, cleavage or attritional heat – is highly effective yet gentle and safe even with explosives.

Receiving
Scoops cascade material as drum rotates. Movement forces material from both ends to middle. Thus blending is 4-way right from start of charging.

Discharging
Single gate controls charge, discharge. Blending continues throughout discharge phase. Result is no segregation or flotation — highly intimate, even blends.

Self-cleaning, dust-sealed drum; one-man accessibility

Operation of Sturtevant Blenders is self-cleaning – drum interiors are completely dust-sealed. For inspection of all models, one man simply loosens a few lugs to remove manhole cover – quickly and easily.

Nine standard models with capacities to 900 cu. ft.

10 cu. ft. Sturtevant Blender at U.S. Steel Corp.'s new Applied Research Laboratory (Raw Materials Division) in Monroeville, Pa. This unit handles batches up to 500 lbs. — is ideal for pilot work and small runs.

One of four 450 cu. ft. Sturtevant Blenders at Celriver Plant of Celanese Corp. (Rock Hill, N. C.). These large units handle up to 20,000 lbs. batches — have a 9-year record of meeting the most exacting blending requirements.

Fully or semi-automatic, or manually controlled operation

Constructed of carbon steel, stainless steel or Monel metal, Sturtevant Rotary Blenders are engineered to fit each customer's needs – can be supplied with injector sprays and any desired control system.

For more on Sturtevant Blenders, request Bulletin No. 080B. (Bulletins also available on Mixers, Air Separators, Micronizers, Crushers and Grinders.) Write today. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

I GOOFED!

(I didn't buy a Taylor Comparator the *first* time.)

I thought comparators were pretty much the same, but, was *I* wrong! Broke two of those fragile, individual glass standards the first week . . . and things were really fouled up. Got a Taylor Comparator as soon as I could . . . and I'm really sold on Taylor. You can't beat a slide with all the color standards right in it for convenience and easy use.

Taylor Comparators — with guaranteed non-fading color standards in a single slide — let you make fast, easy, accurate tests for pH chlorine, phosphate, silica, nitrate and chromates, etc. . . . right on the spot. You get dependable data to help you control chemical processing, water purification, waste treatment.

ALSO AVAILABLE

Taylor Midget Iron Tester, Taylor Water Analyzer for colorimetric water analysis.

ALL TAYLOR COMPARATORS HAVE GUARANTEED NON-FADING COLOR STANDARDS

SEE YOUR DEALER for Taylor Sets or immediate replacement of supplies.

FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes full Taylor line.

W. A. TAYLOR AND CO.
414 STEVENSON LANE • BALTIMORE 4, MD

LITERATURE . . .

Process Equipment

Agitators & Mixers.....Turbine-type propeller (to 120" in tanks to 50" dia.) slow speed, high speed, air lift, vertical turbine mixers, mixer-settler units. Bul. A2-B2.
158a *Denver Equipment Co.

Attrition Scrubbers.....High power input to efficiently remove sand coating, mix dense slurries. Rubber lined or acid-proof tanks. Sizes to 56" x 56". Bul. A-8505.
158b *Denver Equipment Co.

Blender.....Tri-Rib for agricultural, mineral or chemical mixing. An illustrated brochure on this new type blender is now available on request.
BL196 *Posey Iron Works Inc.

Centrifugals..... Batch-O-Matic can be constructed of stainless steel, "Hastelloy", titanium or other alloys. Corrosion-resistant coatings may be specified. Bul.
149 *American Machine & Metals, Inc.

Collector.....The Amerjet will handle heavy dust loadings of materials of varying nature with a constant pressure drop that assures accurate control. Bul. 279.
10-11c *American Air Filter Co., Inc.

Conveyor, Screw.....17 basic screw designs, available in a variety of metals, are included in the line. Also, complete line of troughs, gates, drives, etc. Data 2289.
13 *Link-Belt Co.

Crushers.....especially designed for handling coke. For screens from ¾ in. to 4 in. openings. Help with any of your coke sizing problems is available.
25 *Jeffrey Mfg. Co.

Dryer.....keeps instrument and tool air desert dry. Case history sheets illustrate in details specificcations & solutions to a multitude of moisture problems.
164 *Pittsburgh Lectrodryer Div.

Dust Collector.....The W Roto-Clone requires little maintenance, uses a minimum of water & maintains efficiency regardless of variation in air volume. Bul. 272B.
10-11a *American Air Filter Co.

Filter.....With the EimcoBelt filter, operation is continuous, with no blinding and no fall-off in filtration rate. Bulletin F-2053 is offered.
Cover *The Eimco Corp.

Filters.....Details on how custom engineered Niagara Filters can help with your processing problems is contained in Bulletin NC-457 which is now available.
148 *American Machine & Metals, Inc.

Filters, Rotary Drum.....These units feature a self-contained variable speed drive, efficient modern lighting and sight glasses. More detailed information offered.
156. *Goslin Birmingham Mfg. Co.

Floats, Stainless Steel.....Bulletin contains construction data, application information, shape specifications, weight tables, buoyancy formulas, etc.
TL196 *Chicago Float Works

*From advertisement, this issue

Andrew J. Syska,
Hayes Research & Development Engineer Reports . . .

KNOW-HOW IS VITAL IN GAS AND LIQUID DRYING

When we developed the Molecu-Dryer®—a unit specially designed to take advantage of the remarkable drying, sweetening, and purifying capabilities of Linde Company's Molecular Sieves—our chief interest was in drying protective atmospheres (hydrogen, dissociated ammonia, etc.) for metallurgical work—to dewpoints well below –100°F. A natural outgrowth of the Molecu-Dryer was the *Nitro-Gen*®*—an automatic cycling generator which produces low cost, high purity nitrogen for blanketing, purging, protecting. Our engineering people have also explored whole new worlds of gas, liquid, and atmosphere drying and separating problems.

NEW DRYING NEEDS APPEAR DAILY

In manufacturing transistors, for example, the Molecu-Dryer has been able to effect big economies by supplying moisture-free air in place of tank nitrogen to protect transistor assembling and sealing operations. Other current projects: instrument air drying, gaseous CO_2 drying, gas separating . . . also drying and separating of liquid or gaseous hydrocarbons.

EQUIPMENT DESIGN IS DYNAMIC!

Each new area of work has necessitated engineered application of standard or special Molecu-Dryer models, to provide optimum adsorption efficiency, top capacity at minimum equipment cost, job-coordinated cycle times, and fast desorption and cooling.

Linde MOLECULAR SIEVES

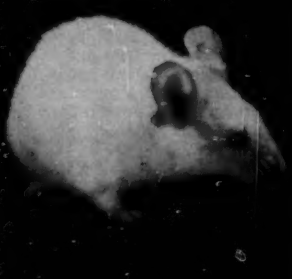
For a comprehensive picture of the Molecu-Dryer, write for Bulletin 5703.

*Hayes TM

C. I. HAYES, INC.
Wellington Avenue • Cranston 10, R. I.
Established 1905

It pays to see Hayes for metallurgical guidance, lab. facilities, furnaces, atmosphere generators, gas and liquid dryers, Pow-R-Trol (TM) control units.

a vacuum pump as quiet as a . . .



Steady and silent. That's the new Stokes Series H Microvac pump. Unique dynamic balancing provides hushed operation. And the compact Stokes pump saves up to 50% in valuable floor space.

Find out all the reasons why you get *more pumping performance per dollar* with Stokes Microvac pumps. Just write: Vacuum Equipment Division, F. J. STOKES CORPORATION, 5500 TABOR RD., PHILA. 20, PA.

STOKES

SEND TODAY for your free Vacuum Slide Calculator.

LITERATURE . . .

Process Equipment.....“Sub-A” Flotation is available in sizes from 16″ x 16″ to 72″ x 72″. “Cell-to-Cell”, “Free-Flow” and Type “M”. Bulletin F10-B86.
158f *Denver Equipment Co.

Reagent Feeders.....Both wet and dry feeders are available. Many standard units in stock. Complete information on these feeders in Bulletin F6-B8.
158e *Denver Equipment Co.

Roller Mills.....with whizzer air separation. Mills are available with single or double whizzer separators. Catalog Number 79E for detailed information.
182 *Combustion Engineering, Inc.

Samplers.....Continuous mechanical & automatic types for dry, solution or slurry sampling. Complete sampling plants & sample processing equipment. Bul. S1-B4.
158j *Denver Equipment Co.

Screens.....for efficient wet or dry screening. “True-Circle” eccentric action. Sizes to 6′ x 14′ in stock. Trommel Screens in sizes from 30″ x 60″ x 120″. Bul. S3-B15.
158k *Denver Equipment Co.

Spiral Rake Thickeners.....move settled materials to center in one revolution. Acid proof construction available. Further information in Bul. T5-B6.
158l *Denver Equipment Co.

Stills.....Barnstead Stills meet every laboratory and industrial requirement. Offer highest purity distillate at lowest cost. Full details in Catalog “G”.
147 *Barnstead Still & Steril. Co.

Testing Sieves.....Feature exact openings, no crevices, strong durable cloth, & cloth is renewable. Available in a complete range of sizes.
151 *Newark Wire Cloth Co.

Trap Strainers.....A wide variety of strainers and filter-strainer units to solve particular problems of installation, operation & maintenance. Bul. 601.
R184 *Multi-Metal Wire Cloth Co.

Wet collector.....Type N Roto-Clone combines action of centrifugal force & thorough intermixing of water & dust-laden air. Complete information in Bulletin 277.
10-11b. *American Air Filter Co.

Pumps, Fans, Compressors

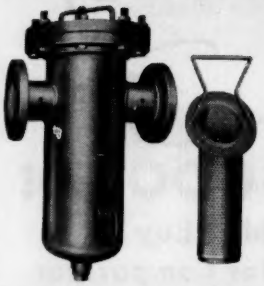
Compressors.....WN112 compressors are built for rugged duty requirements of continuous processes with little maintenance. Bulletin 2562-11 is available on request.
18 *Joy Mfg. Co.

Duct Fans.....Propellers are stainless steel or Dura, a special alloy created for better resistance to corrosive atmospheres. Details in Bulletin 175.
R137 *Aerovent Fan Co., Inc.

Metering Pump.....New Metriflow metering pump with duplex units provide twice the capacity with one motor. Complete information is available on request.
TR196 *Madden Corp.

* From advertisement, this issue

individualized
TO YOUR NEEDS
MULTI-METAL
TRAP STRAINERS



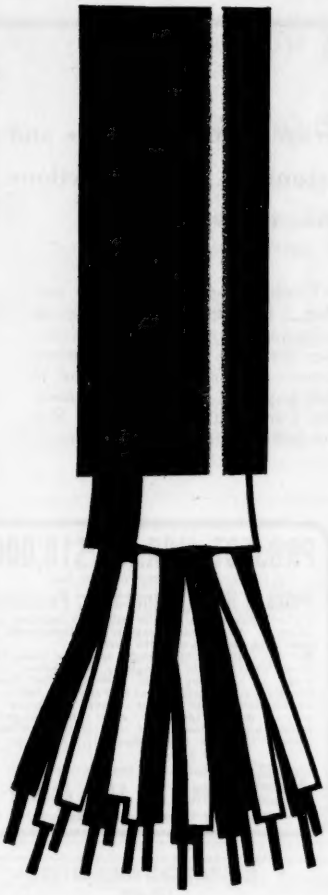
Stainless steel resin trap strainer for demineralized water at 180 psi in nuclear power station.

Basket-within-basket strainer, with quick opening cover for water-soluble adhesives.

Strainer with special shell for PVC resin in solvent, for max. operating pressure of 250 psi.

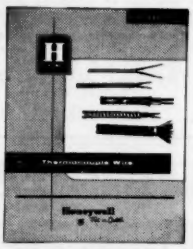
These and many other strainers and filter-strainer units are the result of Multi-Metal's ability to test, design, engineer and produce practical units that solve particular problems of strainer installation, operation, cleaning and maintenance. Bulletin 601 tells how. Get a copy.

MM MULTI-METAL WIRE CLOTH CO., INC.
1353 GARRISON AVENUE, NEW YORK 59, N. Y.



MULTIPLE-CONDUCTOR T/C EXTENSION CABLE

Available with from 4 to 48 pairs of solid-conductor temperature-compensated wires. Each wire is numbered, individual conductors are twisted into pairs, each pair is color-coded by wire type. No conduit needed. Supplied in custom and standard constructions. From this one dependable source come thousands of other accessories to help your instruments perform at their very best.



Get details from your Honeywell field engineer, or write today for Catalog G100-2.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

LITERATURE . . .

Pump, Vertical Centrifugal.....for handling frothy liquids or coarse, sand slurries, constant or intermittent flow. Capacity to 450 gpm. Bulletin P10-B5.
158h *Denver Equipment Co.

Pumps.....range from 25 ot 2500 hp.; pressures to 50,000 psi. Handle corrosive, viscous, abrasive or highly compressive fluids. Complete data.
128 *Aldrich Pump Co.

Pumps.....Vari-Flo pumps change capacity instantly. You can dial this pump for thick or thin flow of liquids. Additional information in Bulletin 600.
T180 *Blackmer Pump Co.

Pumps.....Proportioning pumps for pressures to 100,000 psi. Light Weight, built-in heating or cooling jackets, compact design are some of the features.
138 *McCartney Mfg. Co., Inc.

Pumps.....Moyno pumps are available in capacities to 500 gpm; pressures to 1000 psi. For corrosives, suspended solids & abrasives. Bulletin 100-XX.
81 *Robbins & Myers

Pumps.....A wide variety of heavy duty pumps for the chemical industry. You have 5 gear reductions, 4 pump sizes, 20 capacities. Complete information in Cat. CC, P.27-28.
T176 *Viking Pump Co.

Pumps, Diaphragm.....Stroke can be adjusted while pump is operating. Sizes 1" to 10" simplex and duplex, capacity to 1000 g.p.m. Bulletin P8-B12 offered.
158g *Denver Equipment Co.

Pumps, SRL (Rubber Lined).....Now available in "TRU-GLANDLESS" construction. No sealing water, no packing glands, no slurry dilution. Additional information in Bul. P9-B28.
158i *Denver Equipment Co.

Pump, Vacuum.....The new Series H Microvac pump is designed for compactness. Information about this type plus a Vacuum Slide Calculator are offered.
L184 *F. J. Stokes Corp.

Services & Miscellaneous

Conservation Vents.....designed with flame arrester structure outside the vent housing. UL and FM approved and are made in a wide range of sizes. "Blue Book" offered.
159 *The Protectoseal Co.

Face Protection.....Catalog contains selection of eye and face protection devices for a wide range of industrial application; highlights spectacles with a distinctive modern appearance.
185A Mine Safety Appliances.

Lubrication.....Complete information on various lubricants and lubricating systems and services is contained in Catalog 4600 which is available on request.
185B *Delta-Desco Companies.

Ventilating Systems.....Duracor systems can be easily installed by regular plant maintenance crews. They are corrosion-proof and require only minimum support. Catalog.
139 *Ceilcote Co., Inc.

* From advertisement, this issue

MODERN MATHEMATICS FOR THE ENGINEER

Just Out—2nd Series. 16 noted authorities give practical guidance in modern mathematical techniques and their applications to problems in science and engineering. Covers operators in Hilbert space, asymptotic approximation, random-walk questions, queuing problems, information theory, Monte Carlo and matrix methods, and much more. **Edited by E. Beckenbach, UCLA. 464 pp., 67 illus., $9.50**

MODERN PHYSICS FOR THE ENGINEER

Just Out—2nd Series. Brings you advanced aspects of today's physics that have special application in engineering. Main sections treat the laws of nature, man's physical environment, and technology. Nuclear shell structure, electron scattering and particle accelerators among topics covered. **Edited by L. Ridenour; and W. Nierenberg, Univ. of Cal. 400 pp., 190 illus., $9.50**

CHEMICAL TECHNOLOGY OF PETROLEUM

Covers the chemistry of petroleum and the modern methods, standards, and practices of distillation and refining. Discusses chemical constituents of petroleum, physical properties and common characteristics of the various types, origins, production processes, and products. **By W. Gruse; and D. Stevens, Mellon Inst. of Indus. Research. 3rd Ed. 800 pp., 62 illus., $15.00**

INFRARED RADIATION

An outstanding guide to infrared radiation . . . what it is, what it does, and how it is used. Brings together information on components and laws of physics by which they operate, sources of radiation, methods of transmission, and the analysis and design of systems. Describes hundreds of applications in many fields, ranging from optical systems to satellite instruments. **By H. Hackforth, Nortronics. 288 pp., 169 illus., $10.00**

10 DAYS' FREE TRIAL

McGraw-Hill Book Co., Dept. CE-2-6
327 W. 41st St., New York 36, N. Y.

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus few cents for delivery costs, and return unwanted book(s) postpaid.

☐ Beckenbach—**Modern Math. for the Eng. 2nd Series**—$9.50
☐ Ridenour & Nierenberg—**Modern Phy. for the Eng. 2nd Series**—$9.50
☐ Gruse & Stevens—**Chem. Tech. of Petro.**—$15.00
☐ Hackforth—**Infrared Radiation**—$10.00

Name .....
Address .....
City ..... Zone.... State.....
Company .....
Position .....

For price and terms outside U.S. write McGraw-Hill Intl., N.Y.C. 36 CE-2-6

PROFESSIONAL SERVICES

E. J. CORELL
ENGINEER
Chlorine—Soda Ash—Perchlorethylene
Pigments and Related Products
Design—Reports—Operation
413 Rose Blvd. Tele: Akron, O. TE 64271
Akron, Ohio

THE KULJIAN CORPORATION
Consultants • Consulting • Constructors
Chemical • Industrial • Process
1200 N. Broad St. Phila. 21, Pa.
Offices Throughout the World

CHAS. T. MAIN, INC.
Engineers
Industrial plants
Reports Design Construction Supervision
Boston, Massachusetts Charlotte, North Carolina

FOSTER D. SNELL, INC.
Chemical & Engineering Consultants
Research, Process Developments, Pilot Plant Studies. Plant Design. Location Studies Construction Supervision. Start-up & Operation. Equipment Design. Packaging & Materials Handling Studies. Cost Analyses. Trouble Shooting.
29 W. 15th St. WA-4-8800 New York 11, N. Y.

VON BREE, INC.
Consulting Chemical Engineers
SPECIALISTS IN SULFURIC
Catalyst • Process • Design
Inspections • Evaluations
Pollution Control
20 Monterry Drive Newark, Delaware
ENdicott 8-3674

Searchlight Equipment Locating Service

NO CHARGE OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used equipment not currently advertised. (This service is for USER-BUYERS only.)

How to use: Check the dealer ads on pages 187-193 to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment
Locating Service
Classified Advertising Division
Chemical Engineering
P.O. Box 12, N.Y. 36, N.Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
Classified Advertising Division
CHEMICAL ENGINEERING
P.O. Box 12, N. Y. 36, N. Y.

Please help us locate the following:

.....
.....
.....

NAME .....
TITLE .....
COMPANY .....
STREET .....
CITY ..... ZONE.....
STATE 2/6/61

Employment Opportunities

CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

▶ **Displayed Rates**—$54 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

▶ **Undisplayed Rates**—$2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number counts as 1 line. 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

Editorial Position

Immediate opening on Chemical Engineering's editorial staff of 19 engineer-editors for another young engineer to solicit, evaluate, edit or write technical news stories or articles on process and engineering developments and trends in the chemical process industries. Unusual opportunity to broaden industry and professional contacts, education and experience. Requirements: Degree in chemical engineering or closely related field with 1-5 years experience in chemical process work; ability to evaluate chemical process and engineering information; able to write clearly, concisely and accurately; must like and work well with people; initiative and imagination. New York City location with opportunity for some out-of-town travel. Please send complete resume of education, experience, salary requirement and other pertinent information to:

Personnel Dept.
McGraw-Hill Publishing Co.
330 West 42nd Street
New York 36, New York

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 11: 255 California St.

POSITIONS VACANT

Chemical Process Engineer: Midwest Refinery wants experienced process engineer to supervise operation of wax units. Send detailed resume including salary requirements, in confidence, to P-6007, Chemical Engineering.

Product Development Engineer—Leading converter of plastic film and sheeting has position available in its development division. Must be an "idea Man", for the development of new products drawing from past experience and from laboratory findings of chemical raw suppliers. Position requires imagination and initiative & good background of experience in PVC industry. Send resume to: P-5949, Chemical Engineering.

Wax Chemist: Midwest refinery wants experienced chemist to carry out research and development programs on wax modification. Send detailed resume including salary requirements, in confidence, to P-6002, Chemical Engineering.

EMPLOYMENT SERVICES

Better Positions—$6,000 to $50,000. Want a substantial salary increase, more opportunity or different location? This national 50 year old service connects you with best openings. You pay us only nominal fee for negotiations; this we refund when employer pays placement fee. Present position protected. In complete confidence, write for particulars. R. W. Bixby, Inc., 653 Brisbane Bldg., Buffalo 3, N. Y.

PROJECT MGR./to $18,000
N. J. Client Co. Pays Our Fee
Petro or Heavy Chemicals or Petroleum
An unusual stable growth situation enables our client to demonstrate tangibly an investment in your long term career with them.
But you must be top notch; you must have had direct experience in engineering, management and guidance of major multi million dollar Heavy Chemical or Petro Chemical or Petroleum technical installations, with earlier heavy experience in process design (probably with an engineering service organization.) For confidential and convenient interview call collect Mr. J. Albert at MI 3-2141.
Engineers—Place Engineers
BRENTEN EMP. AGENCY
786 Broad St. (At Market) Newark, N. J.

RESEARCH DIRECTOR
$15,000
Young aggressive organization desires man on PHD or Masters level to assume complete charge of department engaged in research & development in the polymer, rubber, plastics and adhesive field. Client to assume all expenses.
MONARCH PERSONNEL
28 East Jackson Blvd. Chicago 4, Illinois

ASSISTANT PLANT ENGINEER

Leading multi-plant, producer of fertilizers, needs Assistant Plant Engineer for integrated sulfuric, phosphoric and fertilizer plant in Gulf Coast area. Requirements: B.S.M.E. degree or equivalent, and a minimum of two years direct maintenance experience in administering maintenance program, plant modifications and new construction in plants of this type.

Excellent starting salary and Company benefits with opportunity for advancement. Resumes submitted will be given prompt attention and will be maintained in confidence.

P-5842, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

"Put Yourself in the Other Fellow's Place"
TO EMPLOYERS
TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.
MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.
MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section. We make this suggestion in a spirit of helpful cooperation between employers and employees.
This section will be the more useful to all as a result of this consideration.
Classified Advertising Division
McGRAW-HILL PUBLISHING CO., INC.
330 West 42nd St., New York 36, N. Y.

TO THE PROVEN PROJECT MANAGER WHO IS SATISFIED WITH HIS POSITION . . . . . BUT WHO IS CAPABLE OF GREATER MANAGERIAL RESPONSIBILITY

One of the Leading International Engineering Organizations, Located in the New York Metropolitan Area, Now Offers Unexcelled Growth Opportunities With Its Staff of High Level Engineers.

DO YOU HAVE . . .

. . . A Chemical, Mechanical or Civil Engineering Degree?

. . . A minimum of 10 years experience (preferably engineering architectural contracting) in the chemical, petro-chemical or petroleum field?

. . . The initiative to meet the challenge of complex assignments?

. . . The ability to successfully motivate engineering specialists?

IF SO . . .

You may possess the right qualifications for this select opportunity. You will associate with a high level staff group engaged on a wide variety of projects and enjoy outstanding working conditions as well as liberal benefit plans. Your salary will be commensurate with your experience.

TO REPLY . . .

Send letter enclosing a resume or description of your professional experience. All replies will be held in complete confidence.

BOX CE 1784, 125 W 41 ST, NY 36

Plastic Panel Technologist Is Sought by Progressive Manufacturer

The basic strengths in sales and research of the BUTLER MANUFACTURING COMPANY have made its Plastics Department a leader in reinforced plastic panels. To take full advantage of our potential, we are increasing the technical strength of our production staff.

We are seeking a man who will be responsible for improving the efficiency of our present panel production—who can relate sales requirements to specifications for new equipment and plant design. In return, we will offer continually increasing responsibility according to your ambitions and performance.

A Bachelor's Degree in Chemistry or Chemical Engineering is preferred. We desire also that you have had laboratory work in reinforced plastics, as well as experience in devising and improving production processes. A real asset in this work will be your proved ability to innovate.

Your answer, which will be kept in complete confidence, should include a personal resume and be sent to Mr. Orval W. Groves, Employment Supervisor. Butler Manufacturing Company, 7400 East 13th Street, Kansas City 26, Missouri.

BUTLER MANUFACTURING COMPANY

PROCESS ENGINEERS

McKee of Cleveland, Ohio offers permanent career opportunities with a rapidly expanding professional organization. Individuals possessing a minimum of 10 years experience in the design of petroleum, petro-chemical or general chemical producing facilities will be afforded unlimited advancement opportunities.

Reply in confidence to:

G. VICTOR HOPKINS

ARTHUR G. McKEE & COMPANY

2300 Chester Ave. Cleveland 1, Ohio

SEMICONDUCTOR ENGINEERS and SCIENTISTS

SHOCKLEY TRANSISTOR

(Unit of Clevite Transistor)

Offers career opportunities to experienced engineers. Key posts immediately available for:

- PHYSICISTS
- PHYSICAL CHEMISTS
- METALLURGISTS
- ELECTRONIC ENGINEERS
- MECHANICAL ENGINEERS
- CHEMICAL ENGINEERS

Challenging work assignments involving fundamental research and development, circuit design and applications, manufacturing and product engineering, process engineering and supervision.

For further information concerning career opportunities call R. E. Caron, Engineering Placement Director, COLLECT at DA 1-8733 or send résumé in complete confidence to him at

Shockley TRANSISTOR

335 San Antonio Road
Mountain View, California

Equipment Searchlight

(Continued on pages 188-193)

FOR SALE

Periodic Chart—laminated pocket sizes; Elements, atomic weights, densities, etc. Send $1.00—R. and S. Laminating Company, Box 111, White Plains, New York.

EXCLUSIVE RIGHTS OFFERED TO MANUFACTURERS OF SPRAY DRYERS

Unique new conception Parallel Spray Dryer, only 32 ft. high, 1000 lbs. water evap/hr. 100% unbroken heads recovered. Instant-soluble products, foods, vegetable chemicals, soaps. By designer original patented Concurrent Dryer. Best ref. Any solids-containing liquids.

Write Secheurs Atomiseurs Co., 11 Ave., Grande Bretagne, Monte Carlo, Monaco.

CIRCLE A ON READER SERVICE CARD

FOR SALE

Lead lined storage tanks..... 7,500 gal.
Tanks are insulated and fitted with internal lead pipe heating or cooling coils.

Lead lined Kettle..... 2,700 Gal.
Includes 3 HP agitator, jacketed and insulated

TEXTILANA CORPORATION

12607 Cerise Avenue, Hawthorne, California

CIRCLE B ON READER SERVICE CARD

Chemical Manufacturing And Handling Equipment

USED EQUIPMENT—EXCELLENT BUYS

FOR SALE

Gas Converter, GENERAL ELECTRIC, G5, 4000 CFH, 400°F., 125#

Lectrodryer, PITTSBURGH Size 750, Type BWC, 100# W.P.

Drycolene Producer, GENERAL ELECTRIC, 2000°, 200 cu. ft., Type G2

Impregnator, 21" diameter, 11" deep, combination impeller and spinner (2)

Screen Vibrator, J. H. Day, 50" x 116"

Hammermill, swing hammer type, 4½" x 16" opening, 25 HP

Tablet Machine, New STOKES RD3X, 13/16" die, 7 ton

Tablet Machine, COLSON Model 1035, 1", 35 station

Calandria Pan 11'8" diameter, 13' high with vacuum pump

Stainless Tank, 42" diameter x 60" high, 10 gauge bottom discharge

Tanks, vertical and horizontals, 7500-8000 gallon

Acid Proof Bronze Pressure Vessels, 42" x 72", 125# pressure

Muller Mixer, BAKER PERKINS, 36" x 84" opening, 100 HP

Mixer, SIMPSON, 36" diameter tub, 5 HP

Separator, RAYMOND Single Whizzer Type (2)

Dust Collectors, AMERICAN #8 Roto-clone, Type D (9)

Dust Collector, AMERICAN Rotoclone, 5250 CF

Extractor, TOLHURST, 48", 7½ HP, 40 HP

Hydraulic Pumps all sizes

Blowers, CONNORSVILLE Positive Pressure—all sizes

Crane, Model 83 BYERS, ⅜ yd., 38' boom, diesel, magnet, controls, and generator, 1947

Crane, Model 25 NORTHWEST, ¾ yd., 35' boom, diesel

Crane, Model 79 LORAIN, 1¾ yd., 60' boom, diesel

Crane, OHIO Locomotive, 30 ton, 8-wheel, diesel, 50' boom, outriggers, generator, new 1954—LIKE NEW CONDITION.

BEHR MACHINERY & EQUIPMENT CORP.

1242 Seminary Street

Rockford, Illinois

Telephone: WOodland 2-7721

CIRCLE C ON READER SERVICE CARD

Equipment Searchlight

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now.

▶**Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶**Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶Closing Date—March 6th issue closes Feb. 10th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

RECTIFIERS

IGNITRON MERCURY-ARC

Very modern General Electric and Allis-Chalmers 750, 1000, 1500, 2000 and 3000 KW

600 Volts D.C., 13,800 Volts AC

Complete with Transformers and all controls

In our stock and immediately available

CHARLES WEAVER, INC.

19710 JAMES COUZENS HIGHWAY

Detroit 35, Michigan **Phone: BRoadway 3-1900**

CIRCLE D ON READER SERVICE CARD

LOCOMOTIVES—RR CARS & CRANES

9 Gen. Elec. 20, 25, 45, 65, 80, 100& 125 Ton
25-Ton Industrial Brownhoist, 60' Boom Crane
200—50 Ton Box, 300—70 Ton Gondola Cars

PLANT EQUIPMENT

4' Traylor TY Gyratory Crusher
2—Wemco 2M-HMS Plants
No. 5060 Dixie Mogul Hammermill 500 HP
No. 1 Sturtevant Rotary Fine Reduction Crusher F55 Syntron Grizzley Feeder
10—1½ & 2 Yd. V-Shape Dump Cars
2—5' x 3' KVS Air Swept Ball Tube Mills
Ball Mills: No. 56, 5' x 5', 6' x 4' x 9' & 7' x 22'
Hardinge Mills: 3' x 8", 3' x 24", & 10' x 48"
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 8" x 10", 10" x 20", 14" x 28", 18" x 36", 30" x 36", 48" x 60", 48" x 22", 66" x 84"
Crushers, Fine Reduction: 22", 2', 3', 4', 5½', & 7' 848 Cone
Crushers, Roll: 24" x 14", 30" x 14", 40" x 16"
Rotary Dryers: 3' x 30', 5' x 30', 6' x 50', 6' x 70' & 8' x 80'
Rotary Kilns: 36"x30', 6'x70', 7'x120' & 9'x160'
2—42" x 120" Buflovak Atmos. Double Drum Dryer
Roto Louvre #207-10 Type 316 SS, Link Belt
60—1½, 2 & 4 yd Dump Cars
Laboratory Rotary Kiln, 36" x 30', Complete
4' x 10' Tyler-Hummer Electric Vibrating Screen
2' x 6' & 3' x 12' Seco Single Deck Vibrating Screen
2—6' x 12' Allis Chalmers 2 Deck Vibrating Screens
16' Gayco Centrifugal Air Separator
BX-100 Sutton Steele & Steele Air Table NEW
6—30" x 32" Dings Magnetic Head Pulleys
690', 2260', 3068' & 3600'-I.R. Compressors
41000 CFM Sly Dust Collector

WANT BUY DRYERS—KILNS—CRUSHERS

R. C. Stanhope, Inc., 60 E. 42 St., N.Y. 17, N.Y.
Tel. MU 2-3075

CIRCLE E ON READER SERVICE CARD

COMPRESSORS

No better values at any price

110 CFM	3000 PSI Ing. GC 50BW
138 CFM	100 PSI 7x7, Ing. ES, CP & Joy
288 CFM	100 PSI 9x9 Ing. Worth, CP
311 CFM	1500 PSI 10½-7¼-3½-13 IR-ES3
351 CFM	350 PSI 11-5x11 CP TCB-2
364 CFM	100 PSI 10x9 Joy WG 9
465 CFM	100 PSI 12x11-IR-ES CP,T, Worth HB
502 CFM	125 PSI 12x13 Worth HB
593 CFM	110 PSI 13½-8½x8 Worth, DC 2
686 CFM	100 PSI 14x13 Ing. ES
800 CFM	100 PSI 14½-9x7 Ing. XLE
1050 CFM	60 PSI 13-13x12 IR-XRE
1290 CFM	125 PSI 13/8x7 Joy WN114-E
1665 CFM	(actual) 100 PSI C300-300H Fuller
2200 CFM	100 PSI 26-15x18 Ch. Pn. oce 350 HP 3-6-4600 .8 PF
2520 CFM	125 PSI 17-10¾x8 Clark CMA-4L

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N.J. UNion 5-1397

CIRCLE H ON READER SERVICE CARD

ECH SPECIAL

Abbe Eng. Jacketed 5' x 6' Ball Mill, chrome manganese steel. Price $2750.00

EQUIPMENT CLEARING HOUSE, INC.
111 33 Street **Brooklyn 32, N. Y.**
SOuth 8-4451—4452—8782

CIRCLE F ON READER SERVICE CARD

SPECIALS

Column: 24" x 22', 316 stain. steel.
Disintegrators: Rietz RD18-P and RD-12.
Mills: J. H. Day 16x40" high speed 3-roll.
Dryer: American 24x48" dbl. drum.
Dryer: Bowen lab. spray, st. st.
Evaporator: Buflovak sgl. eff. st. st. 94 sq. ft.
Dryer: Porter 2 x 4' vac. drum, st. st.
Centrifugal: Tolhurst 26" rubber. 2-speed.
Filter: Sweetland #5 st. st. lined.
Filter: Eimco, drum 16" x 12".
Vacuum Pans: 42" and 72" stain. steel.
Dryer: Procter & Schwartz 6-tray st. st.
Mixers: Ross 150 gal. paste, 10 hp.
Centrifugal: AT&M 60" st. st. perf.

Write us or call Seeley 8-1431
Send us a list of your idle machines.

LOEB EQUIPMENT SUPPLY CO.
820 W. Superior St., Chicago 22, Ill.

CIRCLE J ON READER SERVICE CARD

Dowtherm 225 KW
Autoclave S.S.—50 gal—2000 lb. pres.
Autoclave S.S.—3½ gal—2000 lb. pres.
Proctor & Schwartz finned drum drier
Centrifuge S.S. 26"—Tolhurst
2 Evaporating Dishes—jacketed S.S. 71" dia.
1 Kettle S.S.—jacketed—500 gal.
2 Kettles S.S. Jacketed—agitated—250 gal.

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. **MI 2-7634**

CIRCLE G ON READER SERVICE CARD

BOILERS: HIGH PRESSURE. We carry a large selection of ASME, National Board high pressure boilers, gas, oil and coal fired, ranging from 10 to 4,000 HP. Each guaranteed in excellent condition. Sale sheet and complete data sent upon request. Write to:

WABASH POWER EQUIPMENT COMPANY
3300 W. Peterson Ave., Chicago 45, Ill.
INdependence 3-0303 and 04.

CIRCLE K ON READER SERVICE CARD

FOR SALE

Integrated gas plant for production of high purity oxygen, hydrogen and nitrogen gases from distilled water. Capacity: 2750 cu. ft. per hr. hydrogen, 1375 cu. ft. per hr. oxygen, 1600 cu. ft. per hr. nitrogen. New 1955. Details on request.

JOYCE EQUIPMENT CO., INC.
406-12 Ward Street Chester, Penna.
Phone: TRemont 4-8496

CIRCLE L ON READER SERVICE CARD

BRILL FOR VALUES

CENTRIFUGES

2—Sharples C-20 and C-27 Super-D-Hydrator, 316 S.S.
1—Bird 18" x 28", Solid Bowl, Continuous, 304 S.S.
2—Bird 24" x 38" Solid Bowl Continuous 304 S.S.
1—Bird 32" x 50", Solid Bowl, Continuous, 316 S.S.
1—Bird 36" x 50", Solid Bowl, Continuous, 347 S.S.
3—Sharples PY14, PN14 Super-D-Canters 316 S.S.
2—Fletcher 48" Suspended 316 S.S. Perforated Basket.
2—Sharples #16, 304 S.S., 3 HP motor.

REACTORS—EVAPS—CONDS—TANKS

2—Glascote 500 and 300 gal. glass lined jacketed agitated Reactors, UNUSED, 125# internal, 90# jacket pressure.
1—150 gal. 304 S.S. jacketed agitated Reactor.
3—Pfaudler 200 gal. glass lined jacketed Kettles.
1—300 gal. Hastelloy B jacketed Kettle.
1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
1—550 sq. ft. Buflovak monel single effect Evaporator.
1—500 gal. S.S. Mixing Tank with nickel coils.
6—7500, 6000 and 2000 gal. Rubber Lined Tanks.
2—1000 gal. 304 S.S. Tanks, 5'6" x 6'.
1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
1—2,000 gal. horiz. 304 S.S. tank, 5' x 12'.
1—2500 gal. vertical 304 S.S. Tank, 8' x 7'.
1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36', 200 psi.
6—Stainless Heat Exchangers; 1220, 786, 536, 370, 315, 250 sq. ft.
1—24" dia. x 35', 304 S.S. Bubble Cap Column.

FILTERS

1—#5 Sweetland Filter 304 S.S. 120 sq. ft.
1—Oliver 6' dia. Horizontal Filter, 316 S.S.
1—Oliver 5' x 6' Steel Rotary Vacuum Precoat Filter.
1—U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
1—Hercules 400 sq. ft. 304 S.S. Pressure Filter.
1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporitite housing.
1—Feinc 3' x 3' Stainless Steel Rotary Vacuum Filter.
2—#12 Sweetland Filters, 36 leaves, 4" centers, 500 sq. ft.
1—Feinc 5' x 6' Stainless Steel Rotary Vacuum Filter.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.
4—36" x 36" alum. P & E, 65 chambers, 1½" cake, hyd. clos.

DRYERS

1—Buflovak Vacuum Shelf with 20—60" x 80" shelves.
7—Devine Vacuum Shelf with 10—40" x 43" shelves.
2—Buflovak 42" x 120", atmospheric double drum Dryers, complete.
1—Buflovak 32" x 90" Atmos. Twin Drum Dryer.
2—Devine 4' x 9' single drum, atmospheric.
1—Buflovak 3' x 10' Rotary Vacuum Dryer.
1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
2—Buflovak 5' x 30', 3' x 7'6" Rotary Vacuum Dryers 316 S.S.
3—Louisville Rotary Steam Tube 5' x 25', 6' x 35', 6' x 50'.
2—Louisville 8' x 50' Stainless Steel lined Rotary Dryers.
9—Rotary Dryers 34" x 30', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
1—Traylor 30" x 18' Stainless Steel Rotary Dryer.
2—Link Belt, 7'5" x 25', 6'4" x 24", S.S. Louvre Dryers.
2—Atmos. Tray Dryers, 16 shelves, 40" x 24".
1—P&S 6' wide Apron Conveyor Dryer 48' long.
2—10' and 4' dia. 304 S.S. Spray Dryers.

MIXERS

1—Farrel-Birmingham "Midget" Banbury Mixer.
2—Day Imperial 150 gal. jktd. double arm.
1—Baker Perkins 100 gal. jacketed double, arm, 30 HP.
1—Baker Perkins 50 gal. jacketed, double-arm.
5—Day 'Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—Patterson 6' dia. Conical Blender 15 HP.
1—3' dia. Simpson Intensive Mixer.
1—4' dia. Lancaster Mixer 7½ HP motor.
1—Patterson Kelly 150 cu. ft. Twin Shell Blender.

MISCELLANEOUS

3—Kinney Vacuum Pumps, 750 cfm, 1 micron, 15 HP.
2—5 and 2½ million Dowtherm Furnaces.
1—Farrel Birmingham 8" x 16" 2 Roll Chrome Plated Mill.
2—Hardinge 5' x 22" steel lined conical Ball Mills.
4—Mikro Pulverizers 4TH, 1 SH, 1 SI and Bantam.
3—Abbe 2½" x 3' porcelain lined Pebble Mill XP motor.
1—Raymond 10" vert. Mill, 10 HP.
1—No. 1 Ball & Jewell Rotary Cutter.
1—#18 Cumberland Rotary Cutter.
3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.
2—#842 Rotex Sifters 60" x 84" double deck.
1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
1—#81 Day Roball Sifter 40" x 120" single deck.
5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.
3—Nash H6 Vacuum Pumps.
25—Chlorimet, Durimet and Duriron Centrifugal Pumps 1½" to 6".
4—Stokes Rotary Tablet Machines DD2-DD52-DS3-RB2.

Partial List of Values—Send for Complete Circular

BRILL EQUIPMENT COMPANY

35-61 JABEZ ST., NEWARK 5, N. J. Tel: MArket 3-7420—N. Y. Tel. RE 2-0820
TEXAS OFFICE: 4101 San Jacinto St., Houston 4, Texas—Tel: JAckson 6-1351

CIRCLE N ON READER SERVICE CARD

FILTER PRESSES—6" lead P&F w/pump, 18x18 (26 chamber), 30x30 (11 chamber)

MILLS—Hardinge Conical, 3'x8", 3'x24", 5'x22", 8'x36", 8'x48", 6'x12' rod w/200 HP

VACUUM PUMPS—115 CFM Beach Russ RP w/5 HP motors, Leiman 105 CFM, Dorr Oliver 200 CFM-piston

DRYERS—ROTARY—24"x22', 3'x24', 4'x40' 5'x50', 7'x58', all w/motor drives.

MIXERS—New 3 qt. sigma/jacketed, 5 gal. Bramley 5 HP vac./jack., 12 gal. sigma, 22 cu. ft. ribbon blender.

E. W. LAWLER has stopped piloting International Jet Liners—Full time super service now for YOU.

MIKRO BANTAM w/vari feed drive, 4TH Mikro (unused) w/Mikro collector & 3x5 Tyler screens for closed circuit.

LAWLER COMPANY

Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE M ON READER SERVICE CARD

TRY IT BEFORE YOU BUY IT

GOOD USED MACHINERY ON APPROVAL

2—Komarek-Greaves 9¼ x 20½ Briquetting Presses, 160,000 PSI with 75 HP Motors
1—Symonds 4' Cone Crusher with hydraulic oil system
2—J H Day 40" x 120" Single Deck Sifter. Mtr & Drive
1—Hendy 40" x 5' Pebble Mill w/Scoop Feed & Screw discharge
1—New Blaw-Knox Rotocel 20' dia x 18 cell. Original crates
2—Dorr 60' Thickener Mechanisms. Each w/sweep arms
2—Raymond #1 auto Pulverizers with Whizzer Separators
3—Lawrence 3" vert. submerged Pumps. 316 SS. 250 GPM @ 100' head

MACHINERY AND EQUIPMENT COMPANY

123 Townsend St. · San Francisco 7, California

CIRCLE O ON READER SERVICE CARD

SPOTLIGHT SPECIALS

Baker Perkins 5 Gal. Dbl. Arm. Jktd. Mixer Pressure Cover; 30 HP

Baker Perkins Hexagonal 150 gal. Jktd. Barratte

2 S/S 30" Micronizers

Buflovak Chrome Plated Lab. Drum Dryer; 6"x 7-⅝"

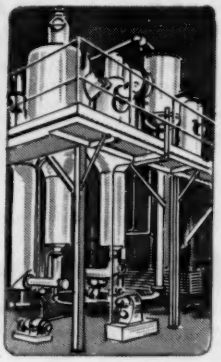
A.T. & M.S/S 60" Centrifuges

Komarek Greaves briquetting Presses; 75 HP. Motors

FMC

SAVE $25,000 on FIRST'S FEATURED SPECIAL

Buflovak Stainless Steel Double Effect Evaporator Model No. 8½—60 D or Buflovak Stainless Steel Sanitary Thermo - Recompression Evaporator with accessories.



SPECIAL OFFERING DIRECT FROM LOCATION CONTINUOUS FINE GRINDING EQUIPMENT BEING REMOVED as OPERATIONS TERMINATE

2—Allis Chalmers 7' x 22' (2 Compartment) Compeb Ball Mills with Meehanite Liners; each with magnetic-coupled 400 HP Motor
1—Allis Chalmers 9½ x 810 Preliminator or Continuous Ball Mill; Meehanite Liners, driven by a magnetic-coupled 400 HP Motor.
3—Allis Chalmers 7' x 22' Continuous Ball Tube Mills with Meehanite Liners, each driven by a magnetic-coupled 400 HP Motor.
Now Operating in Closed Circuit with
3—Raymond 14 ft. Double Whizzer Mechanical Air Separators, New in 1950, each driven by 75 HP Motor.
May be purchased separately.

MIXERS—ALL TYPES

Baker Perkins Double Arm Jacketed Mixers up to 300 Gal.
J. H. Day Cincinnatus Double Arm Mixer; Stainless 300 Gal. Jktd.
Blaw Knox Double Cone Blender 300 cu. ft. 9'6" diameter
Brand NEW Falcon Double Ribbon Mixers, Steel or S/S; all sizes

DRYERS EVAPORATORS

Stokes Vac. Shelf Dryer No. 138D; (7) shelves 24" x 36"
Devine Dbl. Door No. 36 Shelf Dryer; (20) Shelves, 86" x 78"
Louisville MONEL Rotary Steam Tube Dryer; 54" x 35'
2 S/S Acme Continuous Rot. Vacuum Dryers or Concentrators
Double Drum Dryers of Standard Make; 28" x 60" to 42" x 120"
2 F. J. Stokes Vacuum Impregnating Systems; complete
Bowen Stainless Steel Table Model Spray Dryer; 30" x 32"
Bartlett-Snow Jktd. Agtd. Batch Dryer; 6' Dia.; 49 cu. ft.
Zaremba Double Effect INCONEL Evaporator with Calandria
Link Belt Roto Louvre Dryer; Model No. 502-20

REACTORS and PRESSURE VESSELS

Struthers Wells 2000 Gal. Stainless Reactors; Jktd. and Agtd.
2 Stainless 400 Gal. Reactors Jktd. & Agtd. by Struthers Wells
6 Dorr-Oliver 550 Gal. Stainless Thickeners or Reactors
2 MONEL Reactors 2800 Gal. 6'8" x 13'; 175# Intern. & Jtd. Coded
Pfaudler Glass Lined Reactors, Jacketed, Agitated from 50 Gal. to 1000 Gal.

MILLS—GRINDERS—PULVERIZERS

Mikro Pulverizers up to No. 4; Mikro S/S Atomers No. 5 and No. 6
Fitzpatrick Comminutating Machines, in Stainless; Models C, D and K
Abbe Jacketed Steel Ball Mill; 42" x 32"; with charge of balls
International Porcelain Lined Pebble Mills; 8'x8'; 50 HP gear motors

FIRST MACHINERY CORP.

209-289 TENTH STREET, BROOKLYN 15, N. Y.

FMC Pays MORE For Your Surplus

PARKING ON THE PREMISES
Phone: STerling 8-4672
Cable Address: "EFFEMCY"

FMC

CIRCLE P ON READER SERVICE CARD

LIQUIDATION

OMAHA, NEBRASKA

MAJOR ITEMS

3—1000 KVA transformers, 13800—460 volt.
5—Buflovak 42" x 120" dbl. drum dryers, ASME 160#
2—Bonnet 7' x 60' rotary dryers,
1—Bonnet 6' x 52' rotary dryer,
9—Davenport #1A #2A dewatering presses, vari-drives
2—French Oil type 2-S screw-type extraction presses 300 PSI, 60 HP.
2—Sweetland #12 pressure filters,
6—Shriver 48" Cast Iron P. & F. filter presses, (50) chambers, hydraulic closure, closed deliv.
2—19,900 sq. ft. quadruple effect calandria type evaporators, copper tubes, cast iron bodies.
5—24" stainless steel screw conveyors, up to 28' long
6—Ansonia 691 sq. ft. dbl. pipe coolers, copper tubes
3—American 654 sq. ft. spiral steel heat exchangers
18—Tubular heat exchangers, copper tubes: 1500, 1350, 1130, 637, 380, 290, 184, 176, 156 sq. ft.
1—Leader 96" x 44' high steel beer still, perf. trays
4—Leader Iron 96" dia. steel rectifying columns, 44' & 51' high.
2—9500 gal. horiz. cookers, 9' dia. x 20' long, ½" shell & dished heads, agits.
10—Forster hammermills, #8 & #6, 100 & 75 HP.
1—Prater "Blue-Streak" pulverizer,
1—Fuller 12 x 20 pos. press. blower
2—Allis-Chalmers Inter-plane grinders, 100 HP
9—Davenport 5' x 25' screens
2—Warren 12" x 12" cent. pumps
250—Steel centrifugal pumps, 1" to 12", 1 HP to 150 HP
2—Aldrich vert. triplex plunger piston-type pumps, steam drive
20—Steam turbines, to 150 HP

SEND FOR CIRCULAR #960-A

PERRY EQUIPMENT CORP.
1413-21 N. Sixth St.
Philadelphia 22, Pa.
Phone POplar 3-3505

CIRCLE Q ON READER SERVICE CARD

BEST BUY

RAYMOND HI SIDE MILL

Model 5047 with 4 Rolls.
Oil Journals, Air Separators, Fan and Cyclone
Priced To Sell

ME MACHINERY & EQUIPMENT CO.
123 Townsend St. - San Francisco

CIRCLE R ON READER SERVICE CARD

AT PERRY, YOU GET DEPENDABLE CHEMICAL-PROCESS EQUIPMENT - *IN STOCK FOR IMMEDIATE DELIVERY!*

SELECTED RECENT PURCHASES

1—3200 gal. T304SS tank, 6'-6" x 12', dished heads.
1—Hardinge 8' x 48" conical pebble mill.
5—Sweetland #12 pressure filters, stainless leaves.
6—Valley 36" Aluminum P. & F. filter presses.
1—Vulcan 60" dia. x 35 plate T316SS bubble-cap column, vacuum.
1—Buflovak 32" x 52" dbl. drum dryer, ASME 100#.
2—Bird 24" x 38" horiz. centrifugal, T304SS, conical.
1—Buflovak 6" x 8" lab. dbl. drum vacuum dryer.
1—Rotex 40" x 84" Dbl. deck screen.
1—American 42" x 120" dbl. drum dryer, ASME, S/S.
2—200 gal. T304SS reactors, jacketed, agit.
4—1350 gal. T347SS jkt. kettles, anchor agit.
1—3'-6" x 21' rotary dryer, 3/8" welded.
2—Komarek briquette presses, 160,000 PSI roll pressure.
1—Symons 2' standard cone crusher, 30 HP.
1—Feinc 6' x 6' rotary vacuum filter, T304SS.
1—1800 gal. T316SS reactor, Jkt., Agit.
1—Louisville 4'-6" x 25' rotary steam-tube dryer.
1—Baker-Perkins #15-UUMM, 100 gal. dispersion-blade mixer, 100 HP, Jacketed, Compression Cover.

CENTRIFUGALS—FILTERS

1—Bird 18" x 28" contin. cent., monel.
3—Bird 24" x 24" contin., monel, type CH.
2—Bird 24" x 38" contin., conical, T304SS.
1—Bird 32" x 50" contin., horizl, T316SS.
20—Sharples #AS-16V super centrifugals, Inconel Const., vapor-tite, sludge disch. frame.
3—Sharples #C-20 Super-D-Hydrators, T316SS.
1—Tolhurst 48" susp. basket centrif., T304SS.
6—AT&M 40" susp. basket centrif., T304SS.
1—Bird 40" susp. basket centrif., steel.
1—Fletcher 40" susp. basket centrif., steel.
2—AT&M 32" susp. basket centrif., T304SS.
1—Tolhurst 26" susp. basket centrif., steel.
1—AT&M 12" susp. basket centrif., T304SS.
1—Feinc 6' x 6' rot. vac. filter, T304SS, string disch.
2—Oliver 5'-3" x 3' rot. vac. filters, T316SS, precoat.
1—Oliver 5'-3" x 8' rot. vac. filter, precoat, UNUSED.
5—Sweetland #12 steel filters, stainless leaves.
6—Shriver 48" cast-iron P. & F. filter presses.
6—Valley 920 sq. ft. Aluminum P.&F. filter presses, 65 ch., hydraulic closure, 36" x 36".

DRYERS—EVAPORATORS

2—National 10' x 78' rotary dryers, 3/4" shell.
2—Hardinge 8'-8" x 70' rotary dryers, 5/8" welded.
1—Traylor 8' x 80' rot. dryer, 5/8" welded.
2—Davenport 8' x 60' rotary dryers, 7/16" welded.
2—8' x 56' rotary kilns, 1/2" welded shell.
1—7'-6" x 62' rotary kiln, 1/2" welded shell.
1—Louisville 4'-6" x 25' rotary steam-tube dryer.
5—Buflovak 42" x 120" Dbl. Drum dryers, ASME 160#.
1—American 42" x 120" Dbl. Drum dryer, stainless.
1—Buflovak, 42" x 90" Dbl. Drum dryer—atm.
1—American 36" x 84" Dbl. Drum dryer—VACUUM.
1—Buflovak 32" x 52" Dbl. drum dryer, ASME 100#.
1—Buflovak 60" x 144" Single Drum dryer—VACUUM.
2—Buflovak vacuum shelf dryers: 110, 98 sq. ft.
1—Buflovak 5' x 30' rotary vac. dryer, T316SS.
1—Buflovak 3' x 7'-6" rotary vac. dryer, T316SS.
2—Turbulaire 4' dia. spray dryers, T304SS, elec.
1—Bowen lab. spray dryer, T304SS.
1—Mojonnier 2085 sq. ft. triple-effect stainless steel sanitary evap., with preheaters, pans, etc.
4—Buflovak double-effect vertical long-tube stainless evaporators: 1025, 840, 710, 588 sq. ft.

STAINLESS STEEL TANKS

1—5700 gal. horiz., T304SS, 6'-4" x 24', UNUSED.
2—4500 gal. horiz., T304SS, 8' x 12', UNUSED.
1—4300 gal. horizl, T304SS, 6' x 20', ASME 50#.
1—3700 gal. Vert., T304SS, 6' x 17', coils.
1—3400 gal. horiz., T316SS, 6' x 16', dished heads.
1—3300 gal. Vert., T304SS, 6' x 14', hemis. heads.
1—3200 gal. vert., T304SS, 6'-6" x 12', dished heads.
1—3000 gal. Vert., T304SS, 6' x 15', coils.
3—2750 gal. Vert., T316SS, 7' x 8', dished heads.
1—2500 gal. Vert., T316SS, 7' x 7', dished heads.
2—2300 gal. Vert., T316SS, 7' x 8', coils, agit.
4—2250 gal. Vert., T316SS, 7' x 6'-3", agit.
1—2100 gal. Vert., T316SS, 6' x 9'-10", cone bot.
1—1750 gal. Vert., T304SS, 5' x 12', coils.
12—1750 gal. Vert., T304SS hoppers, 235 cu. ft.
1—1600 gal. horiz., T304SS, 5' x 11', dished heads.
6—685 gal. Vert., T316SS, coils.
1—600 gal. Vertl, T304SS, 5' x 4', dished heads.
2—600 gal. vert., T304SS, 4'-6" x 5', dished, agit.

PERRY EQUIPMENT CORPORATION
1413-21 N. SIXTH ST. PHILADELPHIA 22, PA.
Phone POplar 3-3505

CIRCLE 5 ON READER SERVICE CARD

CHEMICAL EQUIPMENT DIVISION

Proudly Presents

Another CHEMICAL PLANT

LIQUIDATION

at NIAGARA FALLS, N. Y.

Pfaudler 500 Gal. Type ELL Glass Lined, Jktd., Agit. Reactor
Dopp 1000 & 1700 Gal. Ni-Resist Doployy, Jktd., Agit. Reactors
Goslin Birmingham 36"x24" Stainless Rotary Vacuum Filter
Buflovak 6"x8" Double Drum Rotary Vacuum Dryer
A.T.&M. 40" & 30" Stainless Susp. Centrifuges, Perf. & Imperf. Baskets
Niagara #12 Stainless Steel Jacketed Filter
Shriver Stainless 18" P&F Closed 4 Eye Washing Filter Press
Buflovak 6' Dia. Crystallizers, Atmospheric & Vacuum
Nash #9, #4, K5 and TS10 Hytor Vacuum Pumps
Stainless & Copper Stills 3500 to 500 Gal.

316 STAINLESS COLUMNS

12"x20' Packed
36"x21' Packed
36"x17'—15 Bubble Cap Trays
48"x40'—40 Bubble Cap Trays
54"x30'—26 Bubble Cap Trays
72"x30'—21 Bubble Cap Trays
78"x18'—14 Bubble Cap Trays

COPPER COLUMNS

24"x 8'—15 Bubble Cap Trays
24"x17'—24 Bubble Cap Trays
30"x11'—12 Bubble Cap Trays
36"x12'—15 Bubble Cap Trays
48"x15'—26 Bubble Cap Trays
48"x31'—50 Bubble Cap Trays
72"x16'—16 Bubble Cap Trays

TANKS

STAINLESS (dished heads)
11000 gal. horiz. 8'x29'6"
6000 gal. Vert. 8' x 18'
5000 gal. Vert. w/coils
4500 gal. Vert. 8'x12'
3500 gal. Vert. w/coils
3500 gal. Horiz. 7'x12'
3500 gal. Vert. 8'x9'
1750 gal. Horiz. 6'x8'
1250 gal. Horiz. 5'x8'
1200 gal. 5'x8' agit.
1000 gal. 5'x7' agit.
950 gal. Vert. 5'x5'
750 gal. 5'x5' agit.
500 gal. 3'6"x8' agit.
500 gal. Vert. w/coils
400 gal. 4'x4' agit.
300 gal. 4'x3' cone bot.
150 gal. 3'x3' agit.
125 gal. Vert. 2'x5'
80 gal. Vert. 2'x3'6"

GLASS LINED
2000 gal. Vert. 6'6"x8'8"
2000 gal. Horiz. 6'x10'
750 gal. Horiz. 5'x5'
400 gal. Vert. 4'x4'

ALUMINUM
18000 gal. Horiz. 10'x30'
12000 gal. Horiz. 9'x26'
7000 gal. Vert. 10'x12'
6000 gal. Vert. 8'x16'
1500 gal. Vert. 5'x10'
750 gal. Vert. 4'6"x6'

COPPER
3500 gal. 8'x9' w/coils
3000 gal. 8'x8' w/coils
2000 gal. 7'x7' w/coils
500 gal. 4'x5' w/coils

STEEL TANKS
22000 gal. Vert. 12'x25'
11000 gal. Horiz. 8'x30'
8500 gal. Vert. 8'x22'
5000 gal. Horiz. 8'x12'
5000 to 250 gal. (50)

HEAT EXCHANGERS
2300 sq. ft. Stainless tubes
1000 sq. ft. All Stainless
600 sq.ft. Stainless tubes
600 sq. ft. Copper tubes
420 sq. ft. All Stainless
300 sq. ft. Stainless tubes
235 sq. ft. Stainless tubes
150 sq. ft. All Stainless
100 sq. ft. Stainless tubes
80 sq. ft. Stainless tubes
68 sq. ft. Stainless tubes
30 sq. ft. Stainless tubes
Glass Lined, jktd 30"x6'

S.S. CENTRIF. PUMPS
2x2" Model 15 DLP LaBour
2x2" Model H15-17 Durco
2x1½" 40-24MD Durco
1½x1" Model DHL LaBour

STAINLESS
COPPER, STEEL, ALUM.
VALVES, PIPE & TUBING

MISCELLANEOUS

Model "D" Fitzpatrick Comminuter
Squire 500 sq. ft. tray truck drier
Str. Wells Electric EH3 Dowtherm Heater
Anders Automatic Air Dehydrator
Dorr Thickeners 20'x4'
Duriron Vessels 1000 to 100 gallon
Foote Bros. gear reducers Type 25W
Swenson 24"x20' Stainless 316 Crystallizer, Jktd.
Roots Connersville 8"x24" Displacement Meter Blower 60000 CFH
Norwalk Compressor Type SRSSR, 15000 PSI
Cleveland Size 400—VD gear reducers

Your Inspection Invited—Representatives on Premises
Write—Wire—Phone for Complete Information

HEAT & POWER CO., Inc.

60 East 42 Street, New York 17, N. Y. Murray Hill 7-5280
Site Office—Pine Ave. & 47th St., Niagara Falls, N. Y. Butler 5-3644

CIRCLE T ON READER SERVICE CARD

MODERN REBUILT MACHINERY

UNION Rebuilt Machinery Established 1912

Baker Perkins, Day, W. & P. Heavy Duty Mixers, 5 to 150 gal. caps., Jacketed and Unjacketed.
J. H. Day and Baily Dry Powder Mixers, 25 lb. to 2000 lb. capacities.
Stokes 90-D Automatic Stainless Steel Tube Filler and Closer.
WRAPPERS: Package Machinery, Hayssen, Hudson Sharp, Battle Creek, Scandia, Wrap-King, all sizes and models.
Pneumatic Scale High Speed Aptomatic Cartoning Line with Feeder, Bottom Sealer, Top Sealer, Wax Liner, Interconnecting conveyors.
Coating Pans all sizes, including 24", 36", 38" and 42".
Colton 6 ft. diameter Stainless Steel Pan.
Stokes & Smith Models G1, G2, HG84, HG87 and HG88 Auger Powder Fillers.
Raymond "O" Pulverizer.
Mikro No. 6 S.S. Atomizer and Bantam, 1SH, 2TH, 3TH and 4TH Pulverizers.
Fitzpatrick Stainless Steel Comminuters.

Complete Details and Quotations Available on Request

UNION STANDARD EQUIPMENT CO.

318-322 Lafayette St. New York 12, N. Y. CAnal 6-5333
167 No. May St. Chicago 7, Illinois SEely 3-7845

CIRCLE U ON READER SERVICE CARD

PROCESS EQUIPMENT

Pebble Mill—42" x 6' Abbe with Buhrstone liners and pebbles. 7½ HP Motor.

Ball Mill—36" x 6' K. V. Saun with extra manganese liners, 15 HP motor.

Oliver Disc Filter—4' diameter, 4 discs, all stainless, replaceable fabric.

Vacuum Pump—5 HP Kinney type 8 x 8 x 10 vacuum pumps with all accessories.

Ore Cooler—triple deck screw conveyor type, jacketed, each flight 9" diameter x 10' long.

Rotary Cutter—Munson #2 Rotary Cutter, with spare knives.

Syntron Feeder—type F-33 DT, totally enclosed, capacity to 1000 lbs. per hr.

Ceramic Valves—Lapp Co. valves ½" to 3".

L. J. LAND, INC.

P. O. Box 756 Reading, Pa. FRanklin 5-8474
P. O. Box 689 Weehawken, N. J. UNion 4-1010

CIRCLE V ON READER SERVICE CARD

PROFIT SAVERS

DORR THICKENER

3 Tray unit. 60' dia x 35' high. Fully equipped with Pumps, Heat Exchangers etc.

Must Move, Save 75%

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE W ON READER SERVICE CARD

Hersey 5'x26' Rotary S.S. Dryer
New 4000 gal. Stainless Tank
Day Hy-R Speed Mill 20 HP XP
SEND FOR LISTINGS
STEIN EQUIPMENT CO.
107—6th Street Sterling 8-1944 Brooklyn 15, N. Y.

CIRCLE X ON READER SERVICE CARD

take the necessary steps to greater profits

Buy

GELB

CHEMICAL PROCESS EQUIPMENT

1—Baker Perkins SS double arm sigma blade mixer, 9 gal.
1—Robinson stainless steel 125 cu. ft. horizontal double ribbon blender
1—Raymond 2 roll high side roller mill
1—Oliver SS rotary vacuum pressure precoat filter, 5'3" x 8'

AUTOCLAVES, KETTLES & REACTORS

2—Blaw Knox 600 gal. steel reactors, complete with double motion agitators and drives, 50# jacket, 50# internal
1—Steel 1200 gal. vertical pressure tank, 150 psi
3—Theo. Walters 300 gal. Hastelloy B jacketed reactors
1—Van Alst 300 gal. stainless steel jacketed kettle
1—Blaw Knox 300 gal. stainless steel vacuum reactor
1—Pfaudler Series EL 750 gal. glass lined jacketed reactor, 90# working pressure jacket, complete with impeller type agitator, baffle and drive
1—Pfaudler 30 gal. Series P, jacketed reactor, complete with impeller type agitator, baffle and drive
1—Struthers Wells type 316 SS jacketed reactor 2000 gal. complete with agitator and drive

DRYERS

2—Bonnet rotary kilns, 8' x 115', complete
1—Bonnet rotary cooler, 8' x 50', complete
1—Allis Chalmers stainless steel rotary dryer, 6' x 50', complete
10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
3—Link Belt steel roto louver dryers, Model 207-10, 310-16, 604-20
2—Buflovak stainless steel rotary vacuum dryers, 5' x 30'
1—Buflovak SS jacketed rotary vacuum dryer, 3' x 15'
2—Stokes SS jacketed rotary vacuum dryers, 3' x 15' and 2' x 6'
1—American 42" x 120" double drum dryer, ASME, N. B. constructed, complete with drives and motors
3—Buflovak steel jacketed rotary dryers, 3' x 15', 5' x 20', 5' x 35'
1—Western Precipitation Corp. SS pilot plant spray dryer, Type N-2
1—Bowen Stainless Steel pilot plant spray dryer
1—Stokes single door vacuum shelf dryer with 6 shelves, 24" x 36"

FILTERS

12—Sweetland #12 filters with 72 stainless steel leaves
1—Niagara stainless steel filter, Model 510-28
1—Oliver horizontal filter, 3'
1—Oliver stainless steel rotary vacuum filter, 3' x 4'
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
10—Shriver plate and frame filter presses 12" to 42"

CENTRIFUGES

1—AT&M 48" stainless steel, suspended type centrifuge, complete with plow, motor and imperforate basket
1—Fletcher 48" stainless steel, underdriven centrifuge, complete with perforate basket and motor
7—Western States 40" type 316 SS, suspended type centrifuges, complete with perforate baskets, plows and 40 HP motors
1AT&M 26 type 316 SS, suspended type centrifuge, complete with perforate basket, plow and motor

THE GELB GIRL—FEBRUARY 1961

4—Tolhurst 40" center slung rubber covered centrifuges, complete with perforate baskets and motors
1—Tolhurst 30" center slung rubber covered centrifuge, with perforate basket and motor

MIXERS

2—Sturtevant #7 dustite rotary batch blenders, NEW
15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Baker Perkins, Size 16, Type UUEM, 150 gal. jacketed double arm dipersion type mixer, complete with compression cover and 100 HP motor
1—Stokes stainless steel granulating mixer, Model 21-J
1—Colton stainless steel granulator, Model 561-S

MISCELLANEOUS

1—Stewart Bolling 2 roll chrome plated, plastic mill, 8" x 16"
1—Ross 6" x 14", 3 roll paint mill, high speed, complete
1—Vulcan stainless steel bubble cap column, 4' x 25 plates
1—Badger type 316 SS bubble cap column, 42" diam. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 and 600 sq. ft.
1—Downington type 316 SS heat exchanger, 750 sq. ft.
1—Griscom Russell stainless steel heat exchanger, 900 sq. ft.
4—Patterson type 316 SS condensers, 200 and 300 sq. ft.
20—Davis Engineering stainless steel heat exchangers, 102, 119, 136, 166 sq. ft. NEW
4—Davis Engineering Carpenter 20 heat exchangers, 125 sq. ft., NEW
2—Swenson type 316 SS vacuum crystallizers, 3'6" x 12' and 2' x 12'
3—Mikro #1SH pulverizers, complete
1—Mikro #2TH pulverizers, complete
2—Mikro #3TH stainless steel pulverizers, complete with 40 HP motors

1—J. H. Day SS double arm sigma blade, vacuum jacketed mixer, 5 gal.
1—Hersey stainless steel rotary dryer, 3' x 20'
1—Alloy Fabricators SS jacketed reactor, 400 gal., complete with turbine agitator and Mixco drive
1—Pfaudler Series EM 300 gal. glass lined jacketed reactor, complete with anchor type agitator and drive

R. GELB & SONS, INC.
U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900
75 ANNIVERSARY

CIRCLE Y ON READER SERVICE CARD

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I.Q."* of engineers . . .
(*"Income Quotient")

Communicating your convictions gains better understanding, improved relations, greater results for engineers

Breathes there a man with soul so dead, who never to his friend has said, "Don't those lamebrains in the_____ Department ever get ANYTHING right? . . . I very carefully wrote EVERYTHING down, very logically and clearly . . . didn't leave a thing out . . . and they still don't get my point!" — or words to that effect?

The only qualification you need for having voiced these sentiments is that you occupy yourself daily with one or more **people**, because it is with **people** that communications break down — people on either end of the chain of communication, whether they be employee or employer, buyer or seller, veteran or newcomer. **(See Footnote)**

Whether it be an internal or external message, verbal or written, a telephone message or a memorandum, a formal report or a business letter, technical or elementary, a progress report or a comparative, scientific analysis, the ground-rules are the same for successful communications.

Take our friend who is beset by "those lamebrains," for instance. Can he be so positive that it was the **other** end of the chain that bogged down? Perhaps he was **too complete** in his instructions, where simplicity would have sufficed. Perhaps the receiver merely needed short, concise directions, not the logical, careful rationalization of the writer. Perhaps his memorandum was clear to **him**, but maybe the "practical examples" he gave weren't so practical to the recipient because it was **outside his frame of reference**, background or experience. Maybe a telephone call would have been a more efficient medium of exchange in this instance.

The basic problem, then, is one of needing to transmit our beliefs, decisions, conclusions from us to someone else, and to have that other person **understand what we mean** — quickly, accurately, simply and — pleasantly.

Perhaps one of the cardinal rules for better communications, then, is **better understanding**: consideration for others, and a **desire** to understand another's viewpoint. Actually, this merely bespeaks the real origin of "fluid communications": **thought**, for thought plays a vital role in what we feel, observe, write, say, or demonstrate; and these are the principal means of communication available to everyone: thinking, feeling, observing, writing, saying, demonstrating. **(See Footnote)**

Does this sound like a monumental, life-long task? It is, and it isn't. It is **not** monumental unless you make it so by resenting it, and it is life-long, because as you change, as others change, as business changes, so do communication forms, vocabularies, meanings, frames of reference.

It is not sufficient in a competitive economy to **have** convictions; it is necessary to **sell** your convictions to someone who can either do something with them, or authorize you to do so. This, then is one of the chief values of communications; to help you accomplish your aims in engineering, in your professional life, more quickly, more productively, more successfully. Combined with your technical knowledge, your ability to perform and deliver, and your initative, communications can become the most valuable tool in your professional "workshop."

FOOTNOTE: For more detailed information, write for Booklet E-1, "Communicating Your Convictions," to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and if there's a heat exchanger in your company's future, we'd appreciate a "line of communication" from you!

Index of Advertisers

Aerovent Fan Co. 137
Aldrich Pump Co. 128
Allied Chemical Corp. General Chemical Div. 39
Allis-Chalmers 133, 135
American Air Filter Co. 10-11
American Air Liquide 144
American Chain & Cable Co. R & PC Valve Div. 117
American Machine and Metals, Inc. 148, 149
Anaconda American Brass Co. 146
Antelline, Inc., Fred F. 195
Armstrong Machine Works 23
Automatic Transportation Co. 119
Autonetics, Division of North American Aviation, Inc. ... 198

Bailey Meter Co. 84
Barber-Greene Co. 21
Barnstead Still & Sterilizer Co. 147
Barton Instrument Corp. 142
Becco Chemical Div., Food Machinery & Chemical Corp. 71
Beckman Instruments, Inc. 24
Bendix Computer Division, Bendix Corporation 12
Bethlehem Steel Co. 14
Bird Machine Co. 2
Bishop & Co. Platinum Works, J. ... 61
Black Sivalls & Bryson, Inc. (Safety Head) 145
Blackmer Pump Co. 180
Buell Engineering Co. 179

Camco Fittings, Inc. 150
Cardinal Scale Mfg. Co. 136
Carrier Air Conditioning Co. 20
Ceilcote Co. 139
Chicago Bridge & Iron Corp. ..... Third Cover
Chicago Float Works, Inc. 196
Clark Equipment Co. 28
Combustion Engineering, Inc. Raymond Division 82
Corning Glass Works 169

Davenport Machine & Foundry Co. 197
Dean Products, Inc. 194
Dempster Bros. 175
Denver Equipment Co. 158
Detecto Scales, Inc. 195
Dixon Corp. 197
Dorr-Oliver Incorporated 36-37
Dow Corning Corp. 15
Dracco Division Fuller Company 41
Duraloy Co. 170
Duriron Company, Inc., The 121

Eimco Corporation ..... Second Cover
Electric Machinery Mfg. Co. 141
Ever-tite Coupling Co., Inc. 45

Falk Corporation 53
Fisher Governor Co. 19, 178
Fluid Energy Processing & Equipment Co. 140
Foxboro Co. 29
Fuller Company 177

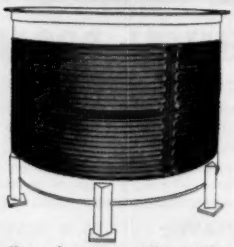
Gabb Special Products, Inc. 154
Gardner-Denver Co. 113
Garlock Inc. 16
General American Transportation Corp. (Kanigen) 47
Goodrich Industrial Products Co., B. F. 1
Goslin-Birmingham Mfg. Co. 156
Gray Tool Co. 160

Harbison-Walker Refractories Co. . 57
Hardinge Co. 172
Harrisburg Steel Co. 51

HEAT YOUR TANK THE MODERN LOW COST WAY

with superior

DEAN PANELCOIL



Regardless of your operation or the size or shape of your tank, if it is heated or cooled, Dean Panelcoil can do the job more economically and more efficiently than old-style pipe coil or jacketing.

For complete technical data and pricing, write for Data Sheet 15-60 Series and Price Bulletin 259.

DEAN PRODUCTS, INC.
1039 Dean St., Brooklyn 38, N. Y.
STerling 9-5400

– Backed by 25 Years of Panel Coil Manufacturing

Excelon

TUBING!

NATIONALLY DISTRIBUTED

for Industrial and Laboratory uses and whenever Flexibility, Clarity and Chemical Inertness is required

Complete range of standard sizes.

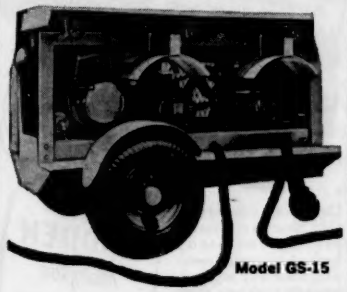
Other sizes quoted upon request.

TP **THERMOPLASTIC PROCESSES, INC.**

Specialists in Rigid Plastic Profiles and Flexible Tubing

VALLEY ROAD, STIRLING, NEW JERSEY
Millington 7-1000-1-2 Mitchell 3-4600
N Y — COrtland 7-6220

NEW PORTABLE
AIR COOLING
UNIT
FOR INDUSTRIAL USES



Model GS-15

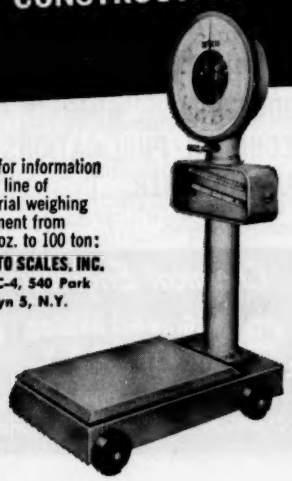
Provides fresh refrigerated breathing air to personnel. Eliminates exposure to hazards created by contaminated air conditions that exist in the various phases of manufacturing, cleaning and maintenance processes. Provides body temperature comfort under high ambient conditions. Adaptable to any type of protective suit or coverall. Save man hours and down-time. Send for literature and specifications.

Our 27th year . . . engineering for any specific air conditioning requirement.

WRITE, WIRE OR PHONE

ANTELLINE
CONSTRUCTORS
1852 MOORE STREET
San Diego 1, Calif. CY 8-7737

DETECTO SCALES
and only
DETECTO SCALES
can say,
"ALL STEEL CONSTRUCTION"



Write for information on full line of industrial weighing equipment from 1/100 oz. to 100 ton:
DETECTO SCALES, INC.
Dept. C-4, 540 Park
Brooklyn 5, N.Y.

Harshaw Chemical Co. 67
Haynes Stellite Co., Div. of Union Carbide Corp. 131
Hayes, Inc., C. I. 183
Hough Co., Frank G. 17

Jeffrey Manufacturing Co. 25
Johns Manville (Celite) 75
Joy Manufacturing Co. 18

Kellogg Co., M. W. 69
Kemp Mfg. Co., C. M. 161

LaBour Company 22
Lapp Insulator Co. 125
LimiTorque Corporation 30
Link-Belt Co. 13
Lukens Steel Co. 111
Lunkenheimer Co. 34

Madden Corp. 196
Magnetrol Inc. 180
Marsh Instrument Co., Div. of Colorado Oil & Gas Corp. 197
McCartney Mfg. Co. 138
McGraw-Hill Book Co. 185
Metal Hydrides, Inc. 4
Mine & Smelter Supply Co. 143
Minneapolis-Honeywell 6-7, 185
Morehouse-Cowles, Inc. 195
Multi-Metal Wire Cloth Co. 184
Murray Mfg. Co., D. J. 168

Nash Engineering Co. 171
National Filter Media Corp. 163
Newark Wire Cloth Co. 151
Niagara Filters Division 148
Nicholson & Co., W. H. 157
Norton Company 63

Perfecting Service Co. 173
Permutit Div. of Pfaudler Permutit, Inc. ..... Fourth Cover
Philadelphia Gear Corp. 30
Pittsburgh Lectrodryer Div. McGraw-Edison Co. 164
Platecoil Division Tranter Manufacturing, Inc. 127
Posey Iron Works 196

Advertising Sales Representatives

Atlanta 9 ..... R. K. Burnet
1375 Peachtree St. N.E., TRinity 5-0523
Boston 16 ..... A. S. Reed
McGraw-Hill Bldg., Copley Square, COngress 2-1160
Chicago 11 ..... Gene Davis, J. M. Rodger, Jr.
520 N. Michigan Ave. MOhawk 4-5800
Cleveland 13 ..... John G. Mitchell
55 Public Square SUperior 1-7000
Dallas 1 ..... Robert T. Wood
Vaughn Bldg., 1712 Commerce Riverside 7-9721
Denver 2 ..... John Patten
1700 Broadway ALpine 5-2981
Detroit 26 ..... Chas. M. Crowe, Jr.
856 Penobscot Bldg. WOodward 2-1793
Frankfurt/Main ..... Stan Kimes
85 Westendstrasse
Geneva ..... Michael R. Zeynel
2 Place du Port
Houston 25 ..... Gene Holland, John Grant
W-724 Prudential Bldg. JAckson 6-1281
London W1 ..... E. E. Schirmer, Edwin E. Murphy
34 Dover St.
Los Angeles 17 ..... John B. Upheff
1125 W. Sixth St. HUntley 2-5450
New York 36, R. G. Frederick, A. L. Gregory, John R. Emery
500 Fifth Ave. OXford 5-5959
Philadelphia 3 ..... E. M. Schellenger
6 Penn Center Plaza LOcust 8-4330
Pittsburgh 22 ..... G. S. Ryan
4 Gateway Center EXpress 1-1314
Portland 4 ..... Scott B. Hubbard
Room 445, Pacific Bldg. CApitol 3-5118
St. Louis 8 ..... J. M. Rodger, Jr.
3615 Olive Street Jefferson 5-4867
San Francisco 4 ..... R. T. Koch
68 Post St. DOuglas 2-4600

What's News in Milling?

Stainless Steel Morehouse* Mills Protect Against Contamination

Offering all the advantages of the regular "MOREHOUSE" mills—greater production, in less space, at less cost—a complete line of air-cooled and water-cooled stainless models are now available.

The line includes ¾ H.P. laboratory mills, 3-5 H.P. pilot plant and R/D mills, 10-20 H.P. medium production mills and 30-50 H.P. big volume mills. All parts that come in contact with materials being processed are type 316 corrosion resistant stainless steel.

The exclusive "MOREHOUSE" principle is based on high speed, attrition-type milling between specially formulated discs. This principle makes possible extremely compact and efficient machines. Dependent on materials being processed, they are capable of producing up to many times the volume per hour of ordinary mills in a fraction of the space and time.

Micrometer hand wheel controls particle size to .001 of an inch. Adjustments can be easily and quickly made while mill is running.

Collet-type lock maintains exact adjustment, preventing any variance in particle size and thereby assuring exact duplication of end products as desired.

Cleaning is simple and easy.

As a result, "MOREHOUSE" stainless steel mills are used throughout the world on hundreds of costly, perishable products where prevention of contamination is important, including chemicals, drugs, pharmaceuticals, and miscellaneous food products. If you have grinding, dispersing, mixing, emulsifying, homogenizing and disintegrating problems involving end products that must be produced contamination free, it will pay you to investigate "MOREHOUSE" mills for greater volume, higher quality and lower power and maintenance costs.

Let us prove it in your plant at our risk!
Write us today about your problem.

MOREHOUSE-COWLES, INC.
1150 San Fer Road Los Angeles 65, California

MOREHOUSE COWLES

Representatives in Principal Cities.
Convenient Lease and Time-Payment Plans.

Please send me information on use of MOREHOUSE mills in processing (product) .....
.....
Name ..... Title .....
Firm .....
Address .....
City ..... Zone .... State .....
*Reg. U.S. Pat. Off. 405

EVERY ENGINEER
should have a copy of
this new booklet

on STAINLESS STEEL FLOATS

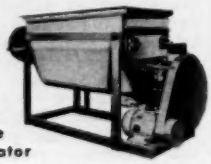
If you have chemical corrosion problems in process equipment, you'll want to have a copy of this authoritative bulletin on Stainless Steel Floats. All the details are here—construction data . . . application information . . . shape specifications . . . weight tables . . . buoyancy formulas . . . and full details on aluminum, monel and nickel floats as well. All the data you need for specifying and ordering. Send for your FREE copy today!

CHICAGO FLOAT WORKS
2344 South Western Ave. • Chicago 8, Illinois

POSEY WORKS FOR BETTER-

PROCESS BLENDING

TRI-RIB
Precisely blends ingredients in ⅓ to ½ the usual time.
For agricultural, mineral or chemical mixing. Three individual agitator screws and counter-flow action insure precision blending.



Write for FREE illustrated brochure on this new type blender.

Custom Fabrication For Over 50 Years

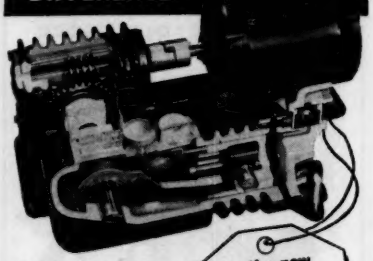
DIVISIONS:
• Iroquois Asphalt Plants • Mixers and Blenders
• Tunnel Forms • Industrial Heating • Foundry
• Large OD Steel pipe

557 S. PRINCE STREET LANCASTER, PA.

ADVERTISERS . . .

Powell Valves, Wm. Powell & Co.	65
Power-Curve Conveyor Co.	178
Protectoseal Co.	159
Pure Carbonic Co.	59
Raybestos-Manhattan (Plastics Products)	152
Research, Inc.	144
Robbins & Myers, Inc.	81
Rockwell Mfg. Co. Nordstrom Valve Div.	27
Rohm & Haas	49
Smith Corporation, A. O. Subsidiary—Glascote Products, Inc.	8-9
Solar Aircraft Co.	80
Stokes Corp., F. J.	184
Stone & Webster Engrg. Corp.	83
Strahman Valves, Inc.	136
Sturtevant Mill Co.	182
Taylor & Co., W. A.	183
Terry Steam Turbine Co.	181
Thermo Electric Co.	155
Thermoplastic Processes, Inc.	194
Toledo Scale, Div. of Toledo Scale Corp.	162
Tolhurst Division	149
Union Asbestos & Rubber Co.	129
Union Carbide Chemicals Co., Div. of Union Carbide Corp.	85
U. S. Steel Corp. National Tube Div.	55
U. S. Stoneware Co.	32
Valcor Engineering Co.	182
Vickers, Inc. Subsidiary of Sperry Rand Corp.	123
Viking Pump Co.	176
Vogt Machine Co., Henry	86
Wallace & Tiernan, Inc.	153
Warrick Co., Charles F.	176
Welded Steel Tube Institute	153
Wiegand Co., Edwin L.	26
Williams Patent Crusher & Pulverizer Co.	31
Wolverine Tube Div. of Calumet & Hecla	73-74
Yuba Consolidated Industries	115
Professional Services	186
CLASSIFIED ADVERTISING F. J. Eberle, Business Mgr.	
EMPLOYMENT OPPORTUNITIES	186, 187
SPECIAL SERVICES	187
EQUIPMENT (Used or Surplus New) For Sale	187-193
American Air Compressor Corp.	188
Behr Machinery & Equipment Co.	188
Brenton Employment Agency	186
Brill Equipment Co.	189
Butler Mfg. Co.	187
Equipment Clearing House Inc.	188
First Machinery Corp	190
Gelb & Sons Inc. R.	193
Heat & Power Co. Inc.	192
Joyce Equipment Co. Inc.	188
Land Inc., L. J.	192
Lawler Co.	189
Loeb Equipment Supply Co.	188
Machinecraft Corp.	188
Machinery & Equipment Co.	189, 190, 192
McGraw-Hill Publishing Co.	186
McKee & Co., Arthur G.	187
Monarch Personnel	186
Perry Equipment Corp.	190, 191
Secheurs Atomiseure Co.	187
Shockley Transistor	187
Stein Equipment Co.	192
Stanhope Inc., R. C.	188
Textilana Corporation	187
Union Standard Equipment Co.	192
Wabash Power Equipment Co.	188
Weaver Inc., Charles	188

UNITIZED CONSTRUCTION MAKES THE BIG DIFFERENCE



in the new MADDEN Metriflow METERING PUMP

Unitized construction means it's completely enclosed, locked in permanent alignment, sealed against leakage, dirt and weather. All moving parts inside run in oil. Heavy duty design includes machine cut gears, outboard bearings on pump drive shaft. Solution heads of special materials available for slurries, corrosive liquids. Four standard sizes, up to 54 GPH, pressures to 300 psi. Duplex units provide twice the capacity with one motor.

Write for complete information on the new Madden METRIFLOW Metering Pump

The MADDEN CORPORATION
1345 Jarvis Ave., Chicago 26, Ill.

author

TALITARIAN. — n. One who
tar'i-an-ism (ô-thôr'i-târ'i-ăn
au-thor'i-ta'tive (ô-thôr'i-tā'ti
from, authority; entitled to ob
thoritative teachings. 2. Ha
peremptory. — au-thor'i-ta'tiv
au-thor'i-ty (ô-thôr'i-ti), n.; p
auctoritas.] 1. Legal or righ
son,
Chemical Engineering
HAS MORE ENGINEERS
ON ITS
PUBLISHING STAFF
THAN ALL OTHER
CHEMICAL PROCESS
INDUSTRIES
TECHNICAL PUBLICATIONS
PUT TOGETHER
hand; —
in support of opinic
ony; witness. b A pre
thor. d Just
influence of
like. — Syn.
thēr-i-zā'shŭ
(ô'thēr-īz), v. t. 1
commission; as, author
act.
tion; as, customs
und for. — au'th
a'thor-ized (ô'thēr-īzd), adj. a
hority. b Sanctioned or

Chemical Engineering
McGraw-Hill Building,
New York 36, N. Y.
Published every other monday for Chemical Engineers in all functions

New...from MARSH!

MARSH
Master-mite
SOLENOID
VALVES

Conduit-type Master-mite. Grommet-type also available.

Small Solenoid Valves that fill a BIG Order

Designed to meet the need for positive-acting tight-seating valves for use on wide variety of media, including oxygen, hydrogen, acetylene, etc.

Two Types:
Conduit type and grommet type. Port sizes 1/8" and 1/4" NPT.

Ten orifice sizes: 3/64" through 1/4".

Wide range of voltages:
Standard with 115 V. A. C. but also available in 12, 24, 208, 230, 460 V. A. C.

Pressure to 540 psi.
Small, but with more strength in the Marsh manner. Coils never overheat. Entire assembly leak tight. Remarkably quiet operation. Cleanable without breaking connections. Used in any position. Bodies either brass bar stock or 18-8 stainless steel. All moving parts stainless. Underwriters' approved for use on oxygen and hydrogen and as safety valves.

Write for new bulletin

MARSH INSTRUMENT COMPANY
Dept. 24, Skokie, Illinois
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.

DO YOU HAVE Drying and Cooling Problems?

Installation of another "DAVENPORT" Rotary Dryer and Rotary Parallel Flow Cooler, which will solve this customer's problem.

Let our engineers consult with you on your Pressing, Drying and Cooling problems or send for our catalog "A" For quick reference consult your Chemical Engineering Catalog.

DAVENPORT MACHINE AND Foundry Company
A DIVISION OF MIDDLE STATES CORPORATION
Davenport, Iowa, U.S.A.

DAVENPORT

PRESSING — DRYING and COOLING Equipment

Continuous DeWatering Presses

ROTARY DRYERS
Steam Tube, Hot Air and Direct Fire

Atmospheric DRUM DRYERS

ROTARY COOLERS
Water and Air

RULON® AND TEFLON®

Replace costly machined or molded parts with formed RULON Tape.

Leading manufacturers across the country are cutting design costs by stamping or post-forming parts from RULON (filled TFE) tape. With Dixon's RULON Tape in thicknesses from .004" to .125", you pay only for what you *use*. You use a *minimum* of material . . . and reduce costs up to 10 to 1. You take advantage of RULON'S plastic memory, too, for tighter fits and better seals.

RULON Tape gives your product these performance-improving qualities: (1) low friction, (2) high wear resistance, (3) low deformation under load, (4) wide temp. tolerance (−400°F to +500°F), (5) chemical inertness, (6) lube-free operation, and (7) zero water absorption.

Whether you need stamped or post-formed parts for pumps, valves, compressors, bearings, meters, or what have you, it pays to rely on (1) Dixon's wide selection of basic shapes (in both RULON and Teflon), (2) Dixon's knowledge of fluorocarbon reinforcing agents, and (3) Dixon's facilities for fabricating parts to print.

See RULON designers guide book — Bulletin #9572 in Sweet's Product Design File, or send details for recommendations. DIXON CORPORATION, 101 BURNSIDE ST., BRISTOL, RHODE ISLAND.

* DuPont T.M.

DIXON

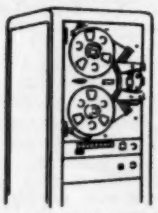
A WORD OF WARNING ABOUT THE NEW ALLUREMENTS OF RECOMP II [and a modest word about price]

Could you be enticed by a computer? Surprisingly, there *are* businessmen and scientists who have allowed their emotions to get quite out of control regarding Recomp II.

And now there is more reason than ever for becoming enamored with this amazing computer. *Three* reasons, to be exact, and all of them new. Hence, our warning to you.

The first reason is, in itself, enough to steal your heart away: it is Recomp II's new reduced lease price. Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at significantly lower terms. And it *still* provides the identical quality, solid-state performance, and features that can't be found on computers costing three times what Recomp II *used* to cost.

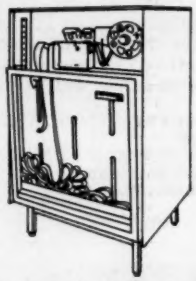
This is heady stuff—but even more enticements lie in wait. You can now add an optional modification to your Recomp II to enlarge its capacity by using magnetic tape. Here you see the new Recomp Magnetic Tape Transport unit.



Naturally it's superbly designed, solid state throughout. But don't let its quietly well-bred air fool you; it has a memory that would stagger an elephant—over 600,000 words. And up to eight of the Transport units can be connected to Recomp II, giving you a computer with a total memory capacity of over 5,000,000 words. Steady there, Mr. Simpson!

The speed of this new magnetic tape control is something to applaud, too: read and write speed is 1850 characters a second; bidirectional search speed is 55 inches per second. Do you begin to see why we warned you about these new allurements of Recomp?

Below you see another new optional feature for your Recomp II: the Facitape tape punch and reader console. It punches 150 characters a second, reads 600 characters a second, and stops on a character. It adjusts to read and punch from 5



through 8 channels. It is versatile, accurate, fast, simple-to-operate, economical, reliable. And it has perfect manners: the mechanical components are completely enclosed in a soundproof housing.

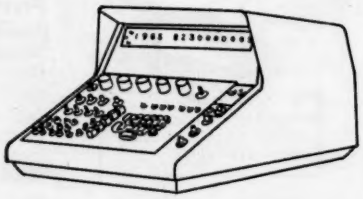
But lest we harp too much on the *new* features of Recomp II, perhaps we had better remind you of some of the extraordinary features that Recomp II *already had*. Features that have always made it the finest computer in the low-priced field.

1] Recomp II is the *only* compact computer with built-in floating point arithmetic. It defies being hemmed in on a problem. With its large capacity it obviates computer-claustrophobia.

2] Recomp II was the first solid-state computer on the market. As you can see by the new features above, Recomp II's scrupulous engineers have seen to it that it remains the *finest* solid-state computer on the market.

3] Recomp II seems to have more built-in features than a dream home kitchen. It has built-in square root command. Built-in automatic conversion from decimal to binary.

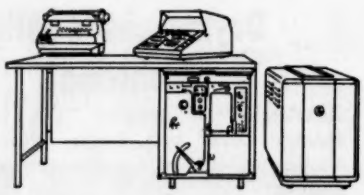
Here you see Recomp II's distinctive keyboard. It looks easy enough to operate—and it *is!* And because Recomp II



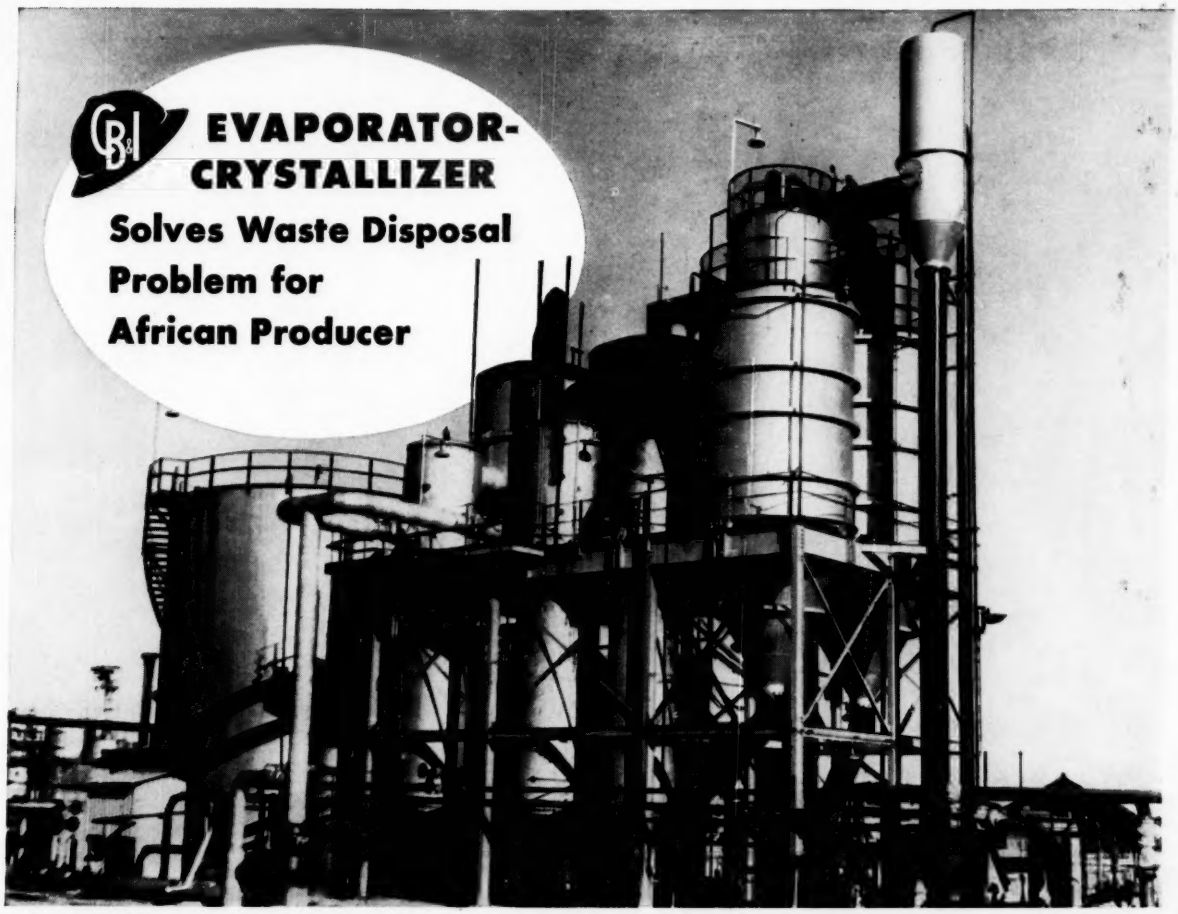
requires no specialized talents, anyone with computer problems can be taught to use it.

One look at Recomp II leaves little wonder that even practical people have allowed their hearts to influence them in choosing Recomp II. Without being showy, it is an object of beauty that reflects its supreme precision of performance. Its distinguished exterior bespeaks the ultimate of excellence; *c'est sans pareil.*

But if you want to avoid being captivated by a computer you should know how strong your emotions will run. May we suggest a *test?* Expose yourself to Recomp II. See it in action. Touch it. Feed problems into it. This is the only way to know how you will react to this extraordinary computer. Make a date to see Recomp II right away.



Write AUTONETICS INDUSTRIAL PRODUCTS, Dept. O26, 3400 E. 70th St., Long Beach, Calif.
The Autonetics Division of North American Aviation, Inc.



EVAPORATOR-CRYSTALLIZER Solves Waste Disposal Problem for African Producer

Continuous operation reported where tough scale problem was anticipated

This four-body, triple effect CB&I Evaporator-Crystallizer was put to work by the South African Coal, Oil & Gas Corporation to process an effluent waste plant liquor—and to produce crystallized acetate compounds from it.

In designing the unit, CB&I engineers were careful to provide for ease and expediency of cleaning and service . . . because of the high scaling tendency of the material. In addition, the unit was built to operate under a special large volume recirculation technique designed to inhibit scale formation. After many months of operation, the plant reports that loss in production time for cleaning amounts to only 3%. Due to the serious plant operating problem that exists when the evaporator-crystallizer is down the unit runs continuously, even during cleaning.

This report shows why so many CB&I customers are *repeat* customers. CB&I equipment is engineered and adaptable to the most exacting operating requirements. As a result, CB&I customers are accustomed to turning a *profit* from high, uniform crystal production—at low operating cost. Write our nearest office for further details on CB&I-built evaporators, crystallizers and filters.

C46C

Above:
CB&I triple effect evaporator-crystallizer at Coalbrook, South Africa has helped South African Coal, Oil & Gas Corporation to solve a difficult waste disposal problem and to recover crystalline materials which may eventually prove to be a new, marketable product.

CB&I Engineers . . . CB&I Fabricates . . . CB&I Erects

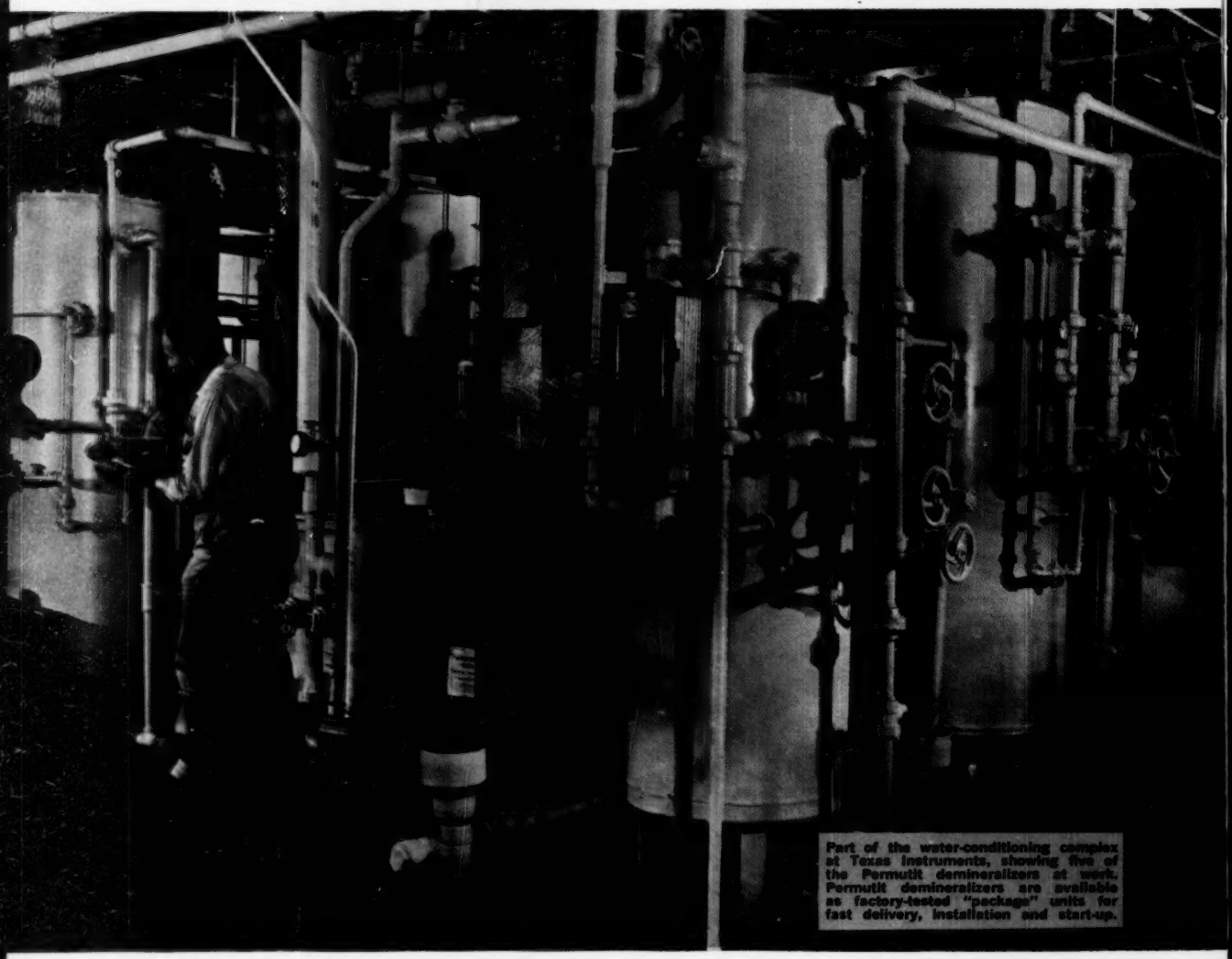
Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in Birmingham • Chicago • Salt Lake City • Greenville, Pa. • New Castle, Delaware

SUBSIDIARIES:
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Chicago Bridge Construcoes Ltda., Rio de Janeiro

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

FLUIDICS* AT WORK



Part of the water-conditioning complex at Texas Instruments, showing five of the Permutit demineralizers at work. Permutit demineralizers are available as factory-tested "package" units for fast delivery, installation and start-up.

From raw water to ultimate water

How Texas Instruments gets ultra-pure water to assure quality of semiconductors

Making transistors is no picnic. One hint of contamination, and you might as well go home.

That's why process water at Texas Instruments must be "ultimately pure."

Starting with a good drinking water but one that contains total solids of about 170 ppm, Permutit® water treatment takes over. A Precipitator, sand filters and activated carbon purifiers clarify the water and completely remove all organic material.

This is still far short of the purity needed for transistor production.

Two-step demineralizers, plus a vacuum deaerator and then mixed-bed demineralizers, remove practically all dissolved solids and all dissolved gases, bringing the water a giant step closer to the ultimate. But it is not until the split-second interval before the water is used in processing that the final purification takes place—in Permutit XP15 mixed-bed polishing demineralizers.

At ambient temperatures (25° C), the resistance of this water is the "ultimate"; virtually no measurable impurities are present to conduct an electric current.

Ultimate water, created by Permutit, may hold an answer to *your* processing problem. Whatever water quality you require, we can help you. Please call us.

To learn more about improving your plant's water, write for one or all of the following: Bulletin 4623, "Ultimate Water"; Bulletin 4721, "Package Demineralizers"; Bulletin 3803C, "Demineralization, Including Silica Removal."

Address requests for literature, or other questions, to our Permutit Division, 50 West 44th Street, New York 36, New York.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.